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An uncertainty spreadsheet for the k0-standardisation method in Neutron Activation Analysis

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Abstract

This paper focuses on the use of the spreadsheet technique to set up the uncertainty budget for the k_0-standardisation method in Neutron Activation Analysis. The adopted measurement model included most of presently recognized error sources and was written to limit the covariances between input quantities. The calculations were implemented in a worksheet file and tested in a multi-elemental analysis of a biological material. Besides, it was demonstrated that the k_0-standardisation turns to the relative-standardisation when the monitor element corresponds to the analyte element. The developed worksheet is available and suitable for the analysis of other materials in different experimental conditions.

Keywords

k_0-standardisation method, uncertainty budget, spreadsheet technique, correlated input quantities, cerebrospinal fluid

Introduction

In 1995, a guide was published by EURACHEM/CITAC [1] to illustrate the use in chemistry measurements of the general rules outlined in the Guide to the Expression of

Uncertainty in Measurement (GUM) [2] for the evaluation and expression of uncertainty. Afterwards, since specific applications in nuclear chemistry measurements were missing in the guide, practical examples for the most common nuclear analytical techniques were included in a report of the International Atomic Energy Agency (IAEA) [3].

The Neutron Activation Analysis (NAA) was addressed in the IAEA report, as regards the existing standardisation methods, i.e. the relative- and k_0-NAA. A detailed list of sources of error were identified and grouped in four categories: i) preparation of samples, ii) neutron irradiation, iii) γ-spectrometry measurements and iv) radiochemical separation, if executed. Two uncertainty budgets were given as examples for the relative-NAA, the first dealing with vanadium in coal fly ash by Instrumental NAA (INAA) and the latter with manganese in animal freeze dried blood by Radiochemical NAA (RNAA). Only one example for the k_0-NAA was cited, with a reference to the (preliminary) evaluation performed by de Corte [4].

Next, several studies focused on the k_0-NAA. Robouch et al [5] suggested the use of the spreadsheet technique developed by Kragten [6] and recommended a general equation to express the uncertainty of the results. Younes et al [7] showed that the sensitivity coefficients, computed by finite difference approximations in the spreadsheet technique, could also be expressed in analytical form. In fact, subsequent works were all based on analytical expressions of the sensitivity coefficients [8, 9].

To date, the most comprehensive examples of uncertainty budgets for k_0-NAA were reported in [9] and concerned the determination of Au, Cr, Rb and Sb in compressed cellulose pellets. The covariances between input quantities, in practice always neglected in the previously available literature, were to some extent considered. However, values and expressions of correlation and sensitivity coefficients were omitted.

In this study, we adopted a measurement equation modeling most of the acknowledged sources of error and written to limit the covariances. Due to the complexity of the resulting functional relationship, we used the spreadsheet technique and the matrix formalism to propagate the uncertainties, including the outstanding correlations. The formulae were implemented and tested for the determination of trace elements in a biological material.

Details on the neutron activation experiment as well as on the characterization of the detection system are here presented to assign estimates, uncertainties and correlation coefficients of the input quantities. Lastly, the uncertainty budgets are briefly discussed to point out the main contributors to the combined uncertainties of the results.

Model

The theoretical basis of k_0-NAA is well established and extensively reported in literature. Simonits et al. proposed the original idea in 1975 [10] following a preliminary study carried out by Girardi et al. [11]. In 1987, de Corte published the most comprehensive development of the method [4], including references to previous papers focused on definitions and assumptions of the standardisation. Here, the basic concepts are briefly recalled to term the input quantities of the measurement model.

The formalism underlying the method is based on a rather simple description of the reaction rate per target nuclide, R, following the Høgdahl convention [12] in the case of a (target) nuclide having a $1/E^{1/2}$ dependence of the (n,γ) cross section function, $\sigma(E)$, versus the neutron energy, E.

According to the convention, the neutron spectrum is divided in the sub- and epi-cadmium regions, respectively below and above the cadmium cut-off energy fixed to 0.55 eV. The fission component is neglected under the hypothesis that the corresponding contribution to R is small. Accordingly:

$$R = G_{\mathrm{th}}\,\Phi_{\mathrm{s}}\sigma_0 + G_{\mathrm{e}}\,\Phi_{\mathrm{e}}I_0(\alpha), \tag{1}$$

where Φ_{s} and Φ_{e} are the (conventional) sub- and epi-cadmium neutron fluxes, G_{th} and G_{e} are correction factors accounting for the thermal and epithermal neutron self-shielding, σ_0 is the thermal cross section, and $I_0(\alpha)$ is the resonance integral for a $1/E^{1+\alpha}$ neutron spectrum in the epi-cadmium region.

The knowledge of the time dependence of the amount of produced radionuclide during and after activation combined to the counting of the emitted γ-photons links the number of target nuclides in a sample, N_t, to the number of counts in the full-energy peak of the collected γ-spectrum, n_p, via R.

With the exception of branching activation and mother-daughter decay, and neglecting burn-up effects, the relation between N_t and n_p is:

$$R\ N_\mathrm{t}\ \varepsilon_\mathrm{p}^\mathrm{geo}\ P_\gamma = \frac{\lambda\, n_\mathrm{p}\ (\delta\ \xi/\mathrm{COI})}{\left(1-e^{-\lambda\, t_\mathrm{i}}\right) e^{-\lambda\, t_\mathrm{d}} \left(1-e^{-\lambda\, t_\mathrm{c}}\right)}, \tag{2}$$

where $R\ N_\mathrm{t}$ is the total reaction rate, $\varepsilon_\mathrm{p}^\mathrm{geo}$ is the full-energy γ-peak detection efficiency for the actual position and geometry of the sample, P_γ is the absolute emission probability of the γ-photons, t_c and t_l are the counting and live times of the detection system, t_i is the irradiation time, t_d is the decay time after irradiation, COI is the true-coincidence correction factor, $\lambda = \ln(2)\,/t_{1/2}$ is the decay constant of the produced radionuclide, given its half-life $t_{1/2}$, $\delta = t_\mathrm{c}/t_\mathrm{l}$ is the dead time correction factor and $\xi = e^{\mu(1-t_\mathrm{l}/t_\mathrm{c})}$ is the excess counting loss correction factor, given the excess counting loss constant of the detection system, μ, defined in [13].

In the case that the (target) nuclide is an isotope of an element in a m mass sample, N_t can be expressed as:

$$N_\mathrm{t} = \frac{w\ m\ x\ N_\mathrm{A}}{M}, \tag{3}$$

where x is the abundance of the isotope, N_A is the Avogadro constant, and w and M are the mass fraction and molar mass of the element in the sample, respectively.

From eqs. (1), (2) and (3), it follows:

$$\frac{\sigma_0\ P_\gamma\ x\ N_\mathrm{A}}{M} = \frac{\lambda\, n_\mathrm{p}\ (\delta\ \xi/\mathrm{COI})}{\left(1-e^{-\lambda\, t_\mathrm{i}}\right) e^{-\lambda\, t_\mathrm{d}} \left(1-e^{-\lambda\, t_\mathrm{c}}\right) \varepsilon_\mathrm{p}^\mathrm{geo}} \frac{1}{m\ w} \frac{1}{\Phi_\mathrm{s}\left(G_\mathrm{th}+\frac{G_\mathrm{e} Q_0(\alpha)}{f}\right)}, \tag{4}$$

where $Q_0(\alpha) = I_0(\alpha)/\sigma_0$ and $f = \Phi_\mathrm{s}/\Phi_\mathrm{e}$. The $Q_0(\alpha)$ value is obtained by applying the formula $Q_0(\alpha) = (Q_0 - 0.429)\bar{E}_\mathrm{r}^{-\alpha} + 0.429/[0.55^\alpha(1+2\ \alpha)]$, where $Q_0 = I_0/\sigma_0$ is the ratio of the resonance integral (for a $1/E$ neutron spectrum in the epi-cadmium region) to the thermal cross section and $\bar{E}_\mathrm{r}$ is the effective resonance energy of the target nuclide.

It is worth remarking that the parameters on the left-hand side of (4) are independent of the experimental conditions of irradiation and γ-counting. In fact, the product $\sigma_0\, P_\gamma\, N_\mathrm{A}$ is a constant quantity and the ratio x/M depends on the isotopic composition.

The k_0-NAA measurement model is derived from the application of (4) to the element to be quantified, i.e. the analyte, and to an element used as a monitor of the of the neutron fluence rate.

The following equation holds under the assumption that analyte and monitor are exposed to the same (constant) values of Φ_s and Φ_e during the irradiation:

$$w_\mathrm{a} = \frac{\left.\dfrac{\lambda\, n_\mathrm{p}\, \delta\, \xi}{\left(1-e^{-\lambda\, t_\mathrm{i}}\right) e^{-\lambda\, t_\mathrm{d}} \left(1-e^{-\lambda\, t_\mathrm{c}}\right)}\right|_\mathrm{a}}{\left.\dfrac{\lambda\, n_\mathrm{p}\, \delta\, \xi}{\left(1-e^{-\lambda\, t_\mathrm{i}}\right) e^{-\lambda\, t_\mathrm{d}} \left(1-e^{-\lambda\, t_\mathrm{c}}\right)}\right|_\mathrm{m}} \frac{k_{0\ \mathrm{Au}}(\mathrm{m})}{k_{0\ \mathrm{Au}}(\mathrm{a})} \frac{\left(G_\mathrm{th\ m} + \frac{G_\mathrm{e\ m}\, Q_{0\ \mathrm{m}}(\alpha)}{f}\right)}{\left(G_\mathrm{th\ a} + \frac{G_\mathrm{e\ a}\, Q_{0\ \mathrm{a}}(\alpha)}{f}\right)} \frac{\varepsilon_\mathrm{p\ m}^\mathrm{geo}}{\varepsilon_\mathrm{p\ a}^\mathrm{geo}} \frac{\mathrm{COI_m}}{\mathrm{COI_a}} \frac{m_\mathrm{m}}{m_\mathrm{a}} w_\mathrm{m}, \qquad (5)$$

where the parameters $k_{0\ \mathrm{Au}}(\mathrm{m}) = \frac{M_\mathrm{Au}\, \sigma_{0\ \mathrm{m}}\, P_{\gamma\ \mathrm{m}}\, x_\mathrm{m}}{M_\mathrm{m}\, \sigma_{0\ \mathrm{Au}}\, P_{\gamma\ \mathrm{Au}}\, x_\mathrm{Au}}$ and $k_{0\ \mathrm{Au}}(\mathrm{a}) = \frac{M_\mathrm{Au}\, \sigma_{0\ \mathrm{a}}\, P_{\gamma\ \mathrm{a}}\, x_\mathrm{a}}{M_\mathrm{a}\, \sigma_{0\ \mathrm{Au}}\, P_{\gamma\ \mathrm{Au}}\, x_\mathrm{Au}}$ are the so-called k_0 factors; subscripts a and m refer to the analyte and to the monitor, respectively.

The k_0 values have been experimentally determined for the most important (n,γ) reactions and γ-photons energies with respect to the 411 keV γ-photons emitted by ^{198}Au produced from ^{197}Au via (n,γ) reaction. A compilation of the recommended $k_{0\ \mathrm{Au}}$, Q_0 and $\bar{E}_\mathrm{r}$ values can be found in [14].

Experimental

To exemplify the use of the equation model (5), we measured a lyophilized sample of cerebrospinal fluid (CSF). The experiment was intended to set up the uncertainty budget and not to reach the minimum uncertainty. The results were given in terms of mass concentrations, $\rho_{\mathrm{a}} = w_{\mathrm{a}}/\upsilon$, where υ is the factor used to convert the mass of lyophilized CSF to the volume of reconstituted CSF.

Preparation of the samples

Ten vials of lyophilized CSF, each one corresponding to 3 mL volumes of reconstituted CSF, were purchased. The content of every single vial was moved to an acid-cleaned 8 mL cut polyethylene (PE) vial and sealed. The mass to volume conversion factor, $\upsilon = 99.2(12)\ \mathrm{mL\ g^{-1}}$, was obtained as the ratio of 3 mL to the average of the (ten) mass differences between the filled and empty (washed and dried out) vials. Here and hereafter, unless otherwise specified, the brackets refer to the standard uncertainty and apply to the last digits.

One sample, about 28 mm length, of an Al-0.46%Co wire (Reactor Experiment, 99.9313% purity, 0.38 mm diameter) was used as a Co monitor. The weighed mass, $m_{\mathrm{m}} = 8.47(5)\ \mathrm{mg}$, was sealed in one PE micro-tube. A conservative 1% relative standard uncertainty was assigned to the declared Co mass fraction value, $w_{\mathrm{m}} = 4.597(46) \times 10^{-3}$ g $\mathrm{g^{-1}}$.

Neutron irradiation

The neutron irradiation lasted $t_{\mathrm{i}} = 6.000(5)$ h and was performed in the 250 kW TRIGA Mark II reactor at the Laboratory of Applied Nuclear Energy (LENA) of the University of Pavia. The quoted uncertainty corresponds to a uniform probability distribution assigned to the t_{i} value and having a 30 s half-width.

The vial containing the lyophilized CSF sample and the micro-tube containing the Al-Co wire were put in one PE container used for irradiation and located in the central channel (CC) of the reactor; the neutron flux parameters at CC, f = 15.6(3) and α = -0.036(6), were recently measured [15]. The position of the lyophilized CSF sample and of the Al-Co wire during the irradiation is shown in Figure 1.

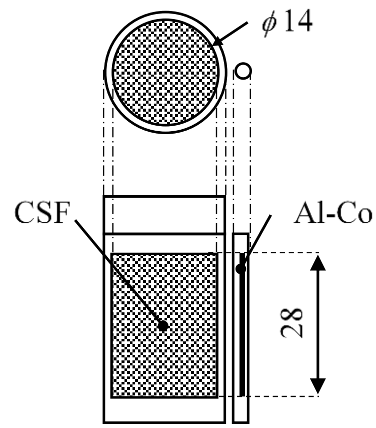

Fig 1 Position of the lyophilized CSF sample and of the Al-Co wire during the irradiation. Dimensions in mm

Gamma spectrometry

After irradiation, the lyophilized CSF sample was moved from its vial to a new 10 mL PE vial and weighed; the mass, m_a, was found to be 240.00(5) mg, corresponding to 23.81(28) mL volume of reconstituted CSF in the case of negligible effect due to humidity. The relative loss of sample was about 20%, probably due to the lyophilized CSF residuals in the vials. The Al-Co wire was removed from its micro-tube, placed in a new 10 mL vial and dissolved using a few drops of nitric and hydrochloric acid (1:1) solution. After complete digestion, water was added to obtain the same volume as the lyophilized CSF sample.

The γ-spectra were recorded with a high purity germanium (HPGe) detector, ORTEC GEM50P4-83 (relative efficiency 50%, resolution 1.90 keV at 1332 keV) inside a low-background graded shield. The detector was connected to a digital signal processor ORTEC DSPEC 502 and the data were collected and processed using the ORTEC Gamma Vision software (version 6.08). The acquisition was performed in extended live-time correction mode using the Gedcke-Hale method with pulse pile-up rejection in automatic set threshold; the excess counting loss constant of the detection system, $\mu = 0.0445(5)$, was recently measured [13].

The position of the lyophilized CSF and dissolved Al-Co wire samples with respect to the detector end-cap is shown in Figure 2a.

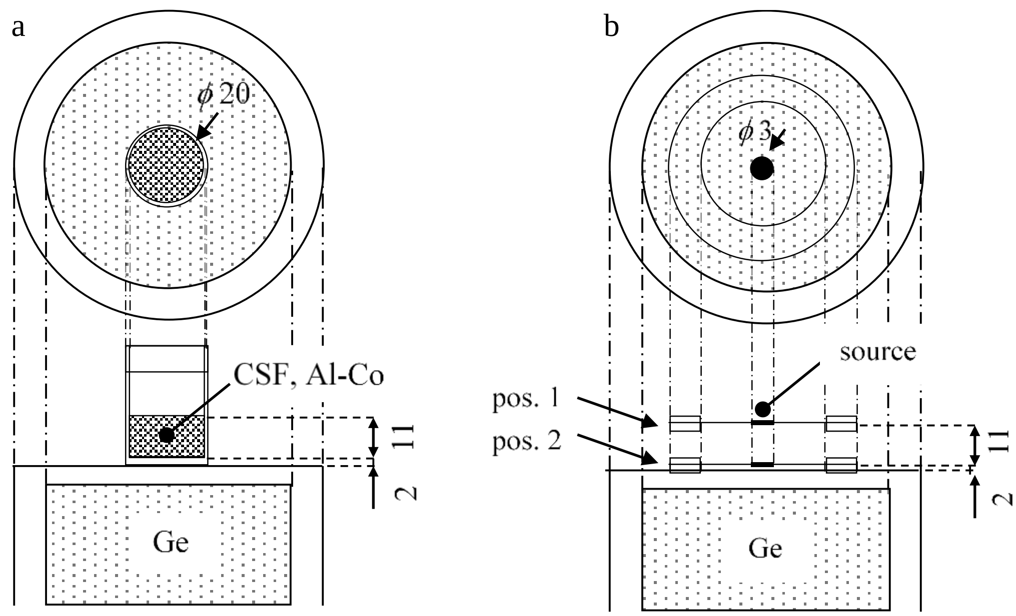

Fig 2 Position of the lyophilized CSF and dissolved Al-Co wire samples (a), and of the disk source (b) with respect to the detector end-cap. Dimensions in mm

The collection of the γ-spectrum emitted by the CSF sample started at $t_{\mathrm{d\,a}} = 667.890(10)$ h, lasted $t_{\mathrm{c\,a}} = 359.0633(1)$ h and ended with a live time $t_{\mathrm{l\,a}} = 351.1856(1)$ h. The dissolved Al-Co monitor was successively measured. The collection of the γ-spectrum started at $t_{\mathrm{d\,m}} = 1034.10(1)$ h, lasted $t_{\mathrm{c\,m}} = 797.0(3)$ s and ended with a live time $t_{\mathrm{l\,m}} = 740.0(3)$ s. The quoted uncertainties correspond to uniform probability distributions assigned to the t_{d}, t_{c} and t_{l} values and having 60 s, 0.5 s and 0.5 s half-widths, respectively.

Detection system characterization

Full-energy γ-peak detection efficiency

The $\varepsilon_{\mathrm{p}}^{\mathrm{geo}}$ values in (5) depend on the actual position and geometry of the measured samples. The dependence is strengthened when extensive samples are measured close to the detector end-cap, as in this case.

In principle, the reconstruction of the $\varepsilon_{\mathrm{p}}^{\mathrm{geo}}$ versus the γ-energy, E_γ, might be performed by measuring the γ-emissions of an extensive standard source having the same shape as the analyte and monitor sample and located at the same position with respect to the detector end-cap. In addition, the material of the source should have the same major elemental composition as the monitor and analyte sample in order to mimic the γ self-absorption.

Actually, a more flexible procedure based on a computational technique coupled to a quasi-point standard source measured at large source-detector distance is commonly adopted [16]; geometries and major elemental composition of sample and layers between the Ge crystal and sample are required.

As an approximated alternative, we recorded two γ-spectra with a disk standard source positioned at the vertical ends of the measured extended samples, as shown in Figure 2b. The efficiency of the (virtual) extensive source, $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$, was estimated by the average of the disk efficiencies in positions 1 and 2, $\varepsilon_{\mathrm{p\,pos1}}^{\mathrm{disk}}$ and $\varepsilon_{\mathrm{p\,pos2}}^{\mathrm{disk}}$, respectively.

The coincidence free γ-emissions selected to reconstruct the efficiency curves were ^{241}Am 59.54 keV, ^{109}Cd 88.03 keV, ^{57}Co 122.06 keV, ^{139}Ce 165.86 keV, ^{113}Sn 391.70 keV, ^{137}Cs 661.66 keV, ^{54}Mn 834.85 keV and ^{65}Zn 1115.54 keV.

The $\varepsilon_{\mathrm{p\,pos1}}^{\mathrm{disk}}$, $\varepsilon_{\mathrm{p\,pos2}}^{\mathrm{disk}}$ and $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ versus E_γ data were fitted by the equation model

$$\ln \varepsilon_{\mathrm{p}} = a_1 E_\gamma + a_0 + a_{-1} E_\gamma^{-1} + a_{-2} E_\gamma^{-2} + a_{-3} E_\gamma^{-3}, \qquad (6)$$

where a_1, a_0, a_{-1}, a_{-2} and a_{-3} are the fitting parameters. Best values, including uncertainties and correlation matrix, were calculated using the algorithm implemented in the OriginPro 2017.

The values obtained with the $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ data were $a_1 = -4.72(43) \times 10^{-1}$ MeV^{-1}, $a_0 = -3.229(57)$, $a_{-1} = 4.03(20) \times 10^{-1}$ MeV, $a_{-2} = -3.20(22) \times 10^{-2}$ MeV^2, $a_{-3} = -5.73(75) \times 10^{-4}$ MeV^3; the corresponding correlation matrix is shown in Table 1.

Table 1 Correlation matrix of the fitting parameters obtained with the $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ data

	a_1	a_0	a_{-1}	a_{-2}	a_{-3}
a_1	1.000	-0.973	0.884	-0.804	0.748
a_0	-0.973	1.000	-0.957	0.896	-0.848
a_{-1}	0.884	-0.957	1.000	-0.984	0.957
a_{-2}	-0.804	0.896	-0.984	1.000	-0.993
a_{-3}	0.748	-0.848	0.957	-0.993	1.000

The $\varepsilon_{\mathrm{p\ pos1}}^{\mathrm{disk}}$, $\varepsilon_{\mathrm{p\ pos2}}^{\mathrm{disk}}$ and $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ versus E_γ curves and the $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ residuals are plotted in Figure 3a and Figure 3b, respectively. The error bars indicate a 95% confidence interval due to fitting, taking into account the correlations.

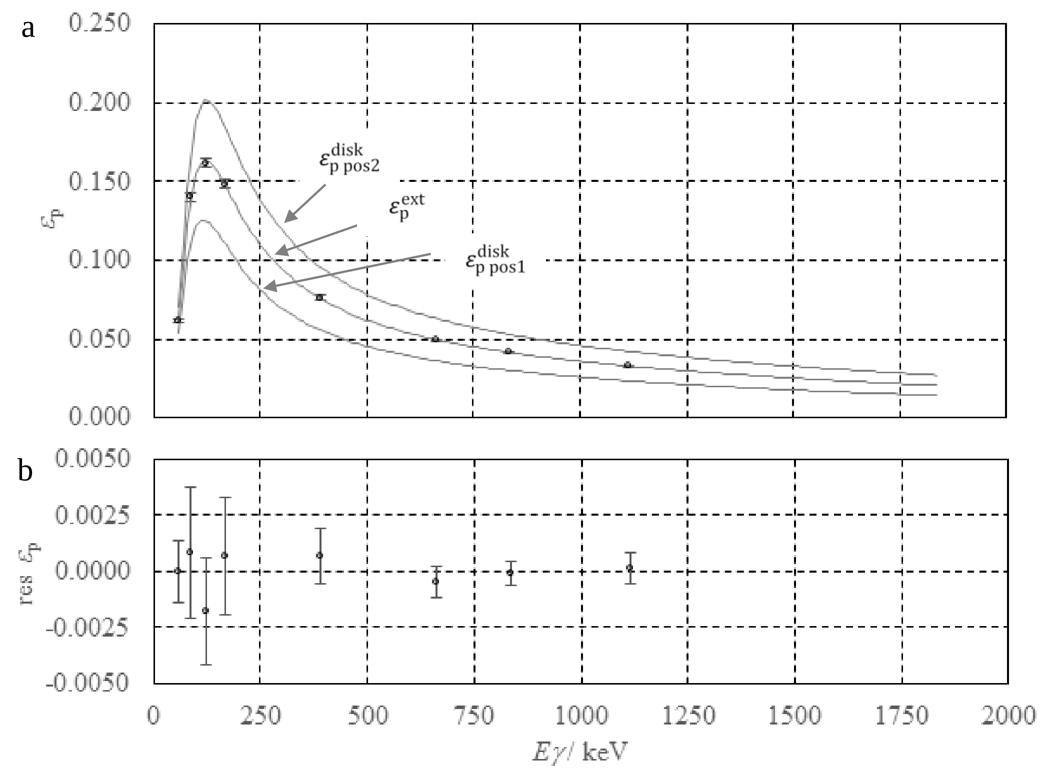

Fig 3 $\varepsilon_{\mathrm{p\ pos2}}^{\mathrm{disk}}$, $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ and $\varepsilon_{\mathrm{p\ pos2}}^{\mathrm{disk}}$ versus E_γ curves (a) and the residuals obtained with the $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ data (b). The error bars indicate a 95% confidence interval due to fitting

Possible differences in counting positions of the measured samples with respect to the (virtual) extensive source were considered according to:

$$\frac{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}}{\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}} = \frac{\varepsilon_{\mathrm{p\,m}}^{\mathrm{ext}}}{\varepsilon_{\mathrm{p\,a}}^{\mathrm{ext}}} \frac{(1-\delta\varepsilon_{\mathrm{r\,m}}\,\Delta d_{\mathrm{m}})}{(1-\delta\varepsilon_{\mathrm{r\,a}}\,\Delta d_{\mathrm{a}})}, \qquad (7)$$

where Δd_{m} and Δd_{a} are the vertical position differences between the dissolved Al-Co wire and the (virtual) extensive source and between the lyophilized CSF sample and the (virtual) extensive source, respectively, and $\delta\varepsilon_{\mathrm{r,m}}$ and $\delta\varepsilon_{\mathrm{r,a}}$ are the relative variations of the detection efficiency per unit of vertical position for the monitor and the analyte, respectively.

The $\delta\varepsilon_{\mathrm{r}}$ values were obtained from the ratio of $\left(\varepsilon_{\mathrm{p\,pos2}}^{\mathrm{disk}} - \varepsilon_{\mathrm{p\,pos1}}^{\mathrm{disk}}\right)/\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ to the difference between the vertical positions 1 and 2, i.e. 11 mm, and plotted versus E_γ in Figure 4.

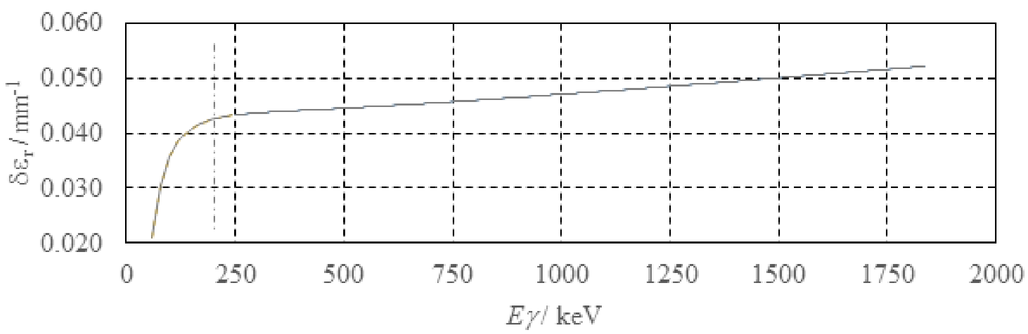

Fig 4 $\delta\varepsilon_{\mathrm{r}}$ versus E_γ curve. The vertical dashed line at about 240 keV splits the curve in two different regions

The data were fitted by $\delta\varepsilon_{\mathrm{r}} = d_0 + d_1E_\gamma$ and $\delta\varepsilon_{\mathrm{r}} = e_0 + e_1E_\gamma + e_2E_\gamma^2 + e_3E_\gamma^3 + e_4E_\gamma^4$, for γ-energies above and below the 240 keV threshold, respectively. The resulting values were $e_4 = -7.10 \times 10^{-11}$ keV^{-4}, $e_3 = 5.19 \times 10^{-8}$ keV^{-3}, $e_2 = -1.43 \times 10^{-5}$ keV^{-2}, $e_1 = 1.78 \times 10^{-3}$ keV^{-1}, $e_0 = -4.46 \times 10^{-2}$ and $d_1 = 5.56 \times 10^{-6}$ keV^{-1}, $d_0 = 4.17 \times 10^{-2}$.

Peak-to-total ratio

True-coincidence occurs when two or more cascading γ-photons are emitted with negligible time delay by a radionuclide. The effect becomes significant when samples are measured close to the detector end-cap.

The number of counts collected in the full-energy γ-peak, n_p, is adjusted using the correction factor

$$\mathrm{COI} = \left(1 - L_\gamma\right)\left(1 + S_\gamma\right), \tag{8}$$

where L_γ and S_γ are the overall probabilities for coincidence loss and summing, respectively [4].

The formulae adopted to calculate L_γ and S_γ values depend on the cascade schemes and include several nuclear parameters, the most important ones being the absolute emission probability of the γ-photons, P_γ, the branching ratio, a_γ, and the total internal conversion coefficient, α_t. In addition, $\varepsilon_\mathrm{p}^\mathrm{geo}$ and the peak-to-total ratio, P/T, of the detection system are required.

E.g., the probability for coincidence loss of γ_A and γ_B in the case of $\gamma_\mathrm{A} \rightarrow \gamma_\mathrm{B}$ decay scheme is

$$L_{\gamma_\mathrm{A}} = a_{\gamma_\mathrm{B}} c_{\gamma_\mathrm{B}} \frac{\varepsilon_{\mathrm{p}\,\gamma_\mathrm{B}}^\mathrm{geo}}{(P/T)_{\gamma_\mathrm{B}}} \text{ and } L_{\gamma_B} = \frac{P_{\gamma_\mathrm{A}}}{P_{\gamma_\mathrm{B}}} a_{\gamma_\mathrm{B}} c_{\gamma_\mathrm{B}} \frac{\varepsilon_{\mathrm{p}\,\gamma_\mathrm{A}}^\mathrm{geo}}{(P/T)_{\gamma_\mathrm{A}}}, \tag{9}$$

respectively, where $c_\gamma = 1/(1 + \alpha_{\mathrm{t}\,\gamma})$, whereas the probability for coincidence summing of γ_A with the $\gamma_\mathrm{B} \rightarrow \gamma_\mathrm{C}$ decay scheme is

$$S_{\gamma_\mathrm{A}} = \frac{P_{\gamma_\mathrm{B}}}{P_{\gamma_\mathrm{A}}} a_{\gamma_\mathrm{C}} c_{\gamma_\mathrm{C}} \frac{\varepsilon_{\mathrm{p}\,\gamma_\mathrm{B}}^\mathrm{geo} \varepsilon_{\mathrm{p}\,\gamma_\mathrm{C}}^\mathrm{geo}}{\varepsilon_{\mathrm{p}\,\gamma_\mathrm{A}}^\mathrm{geo}}. \tag{10}$$

A compilation of the nuclear parameters values and the cascade schemes concerning the radionuclides generally used in NAA are reported in [4].

Similar to $\varepsilon_\mathrm{p}^\mathrm{geo}$, the P/T ratio versus E_γ data can be ideally obtained from γ-spectra of coincidence free radionuclides embedded in extensive sources having the same material and shape as the analyte and monitor sample and located at the same position with respect to the detector end-cap. In practice, since the P/T ratio is above all depending on the position and to a smaller extent on the composition and geometry of the samples, use of quasi-point γ-sources might be accepted.

In this study, we used five γ-emissions, i.e. ^{241}Am 59.54 keV, ^{170}Tm 84.25 keV, ^{203}Hg 279.19 keV, ^{137}Cs 661.66 keV and ^{65}Zn 1115.54 keV, to reconstruct the P/T ratio curve.

The data were fitted by $\log P/T = b_0 + b_1 \log E_\gamma$ and $\log P/T = c_0 + c_1 \log E_\gamma + c_2 (\log E_\gamma)^2$, for γ-energies above and below the 170 keV threshold, respectively. To avoid a discontinuity, the first derivative with respect to $\log E_\gamma$ of the latter equation model at 170 keV was imposed to be the b_1 value. The resulting values were $b_1 = -0.571$, $b_0 = 1.079$, $c_2 = -1.625$, $c_1 = 6.678$ and $c_0 = -7.006$.

The P/T ratio versus E_γ curve is plotted in Figure 5.

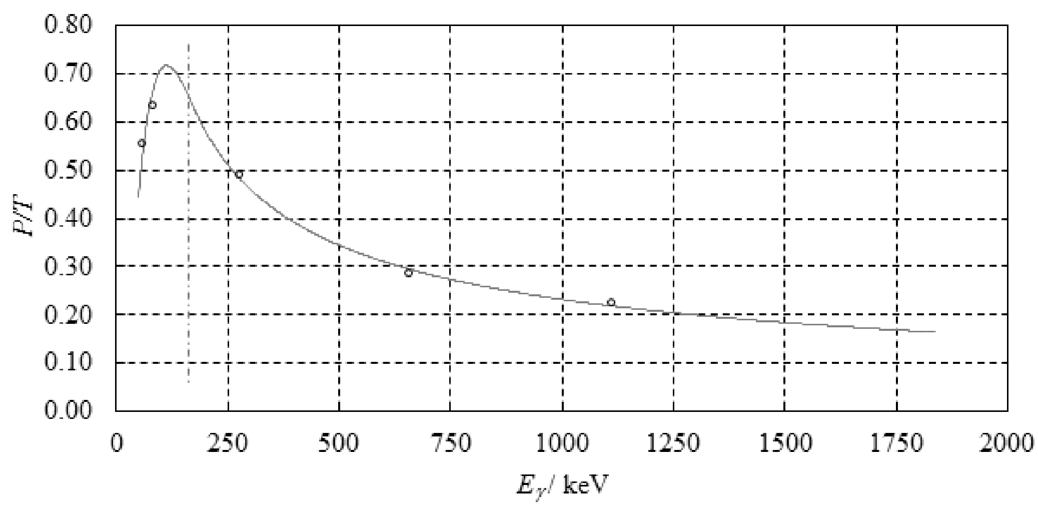

Fig 5 P/T ratio versus E_γ curve. The vertical dashed line at about 170 keV splits the curve in two different regions

Results and discussion

The analysis of the γ-spectrum of the lyophilized CSF sample pointed out ^{233}Pa, ^{51}Cr, ^{131}Ba, ^{124}Sb, ^{46}Sc, ^{86}Rb, ^{59}Fe, ^{65}Zn and ^{60}Co γ-emissions produced by neutron capture reactions from ^{232}Th, ^{50}Cr, ^{130}Ba, ^{123}Sb, ^{45}Sc, ^{85}Rb, ^{58}Fe, ^{64}Zn and ^{59}Co. The mass concentrations of the corresponding elements were quantified using the ^{60}Co γ-emission of the monitor.

The number of counts collected in the γ-peaks were evaluated with the algorithm implemented in the ROI32 analysis engine of the Gamma Vision software. The γ-peak energies and n_p values of the detected radionuclides in the CSF sample and monitor are reported in Table 2; the uncertainty (conservatively) assigned to E_γ corresponds to a uniform distribution with 0.2 keV half-width whereas the n_p uncertainty is due to counting statistics, including background.

Table 2 γ-peak energies and corresponding number of counts of the detected radionuclides

Radionuclide	E_γ / keV	n_p / 1
^{233}Pa$^{(\mathrm{CSF})}$	311.90(12)	1.017(24) × 10^5
^{51}Cr$^{(\mathrm{CSF})}$	320.10(12)	5.26(15) × 10^4
^{131}Ba$^{(\mathrm{CSF})}$	496.30(12)	5.08(12) × 10^4
^{124}Sb$^{(\mathrm{CSF})}$	1691.00(12)	2.47(21) × 10^2
^{46}Sc$^{(\mathrm{CSF})}$	889.30(12)	1.3070(80) × 10^5
^{86}Rb$^{(\mathrm{CSF})}$	1077.00(12)	4.56(44) × 10^3
^{59}Fe$^{(\mathrm{CSF})}$	1099.30(12)	9.46(59) × 10^3
^{65}Zn$^{(\mathrm{CSF})}$	1115.50(12)	1.2260(47) × 10^5
^{60}Co$^{(\mathrm{CSF})}$	1173.20(12)	4.68(44) × 10^3
^{60}Co$^{(\mathrm{monitor})}$	1173.20(12)	1.3749(44) × 10^5

The full-energy γ-peak detection efficiencies ratio, $\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}$, was computed according to (7) using a_1, a_0, a_{-1}, a_{-2}, a_{-3} and d_1, d_0, e_0, e_1, e_2, e_3, e_4 to obtain $\varepsilon_{\mathrm{p\,m}}^{\mathrm{ext}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{ext}}$ and $\delta\varepsilon_\mathrm{r}$, respectively, as a function of E_γ. The uncertainty of the $\varepsilon_{\mathrm{p\,m}}^{\mathrm{ext}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{ext}}$ was evaluated taking into account uncertainties and correlations of the fitting parameters whereas a uniform probability distribution with a (conservative) 20% relative half-width was directly assigned to the $\delta\varepsilon_\mathrm{r}$ value. In addition, it was assumed that the vertical position of the samples was within ±0.5 mm with respect to the (virtual) extensive γ-source; accordingly, $\Delta d_\mathrm{m} = \Delta d_\mathrm{a} = 0.00(29)$ mm, the quoted uncertainty corresponding to a uniform probability distribution having 0.5 mm half-width.

The true-coincidence correction factors ratio, $\mathrm{COI_m}/\mathrm{COI_a}$, was obtained via (8) using b_0, b_1, c_0, c_1 and c_2 to determine P/T as a function of E_γ. A uniform probability distribution with a (conservative) 20% relative half-width was directly assigned to the P/T value. The effect due to possible differences in counting positions was neglected; specifically, $\varepsilon_\mathrm{p}^\mathrm{geo}$ was used instead of $\varepsilon_\mathrm{p}^\mathrm{ext}$ in (9) and (10). Cascade schemes, notations and P_γ, a_γ, α_t values proposed in [4] were adopted with uncertainties corresponding to uniform probability distributions having 0.0002, 0.02 and 0.02 half-widths, respectively.

A list of neutron capture reactions and $t_{1/2}$, $k_{0\,\mathrm{Au}}$, Q_0, $\bar{E}_\mathrm{r}$ values recommended in the k_0 database [14] and used in this study are reported in Table 3 for reader's convenience.

Table 3 Neutron capture reactions and adopted $t_{1/2}$, $k_{0\,\mathrm{Au}}$, Q_0, $\bar{E}_\mathrm{r}$ values.

Reaction	$t_{1/2}$ / h	$k_{0\,\mathrm{Au}}$ / 1	Q_0 / 1	$\bar{E}_\mathrm{r}$ / eV
^{232}Th(n,γ)^{233}Pa	647.280(48)	2.520(13) × 10^{-2}	11.50(41)	54.40(49)
^{50}Cr(n,γ)^{51}Cr	664.800(58)	2.620(13) × 10^{-3}	0.53(11)	753(83) × 10^{1}
^{130}Ba(n,γ)^{131}Ba	276.0(14)	6.480(13) × 10^{-5}	24.8(50)	69.9(35)
^{123}Sb(n,γ)^{124}Sb	1444.80(72)	1.410(16) × 10^{-2}	28.8(11)	28.2(18)
^{45}Sc(n,γ)^{46}Sc	2011.92(48)	1.2200(49)	0.430(86)	513(87) × 10^{1}
^{85}Rb(n,γ)^{86}Rb	447.12(48)	7.650(77) × 10^{-4}	14.80(37)	839(50)
^{58}Fe(n,γ)^{59}Fe	1068.00(14)	7.770(39) × 10^{-5}	0.975(10)	64(15) × 10^{1}
^{64}Zn(n,γ)^{65}Zn	5863.2(24)	5.720(23) × 10^{-3}	1.91(10)	256(26) × 10^{1}
^{59}Co(n,γ)^{60}Co	46207.2(72)	1.3200(53)	1.993(60)	136.0(69)

Values and uncertainties assigned to t_i, $t_{\mathrm{d\,a}}$, $t_{\mathrm{c\,a}}$, $t_{\mathrm{l\,a}}$, $t_{\mathrm{d\,m}}$, $t_{\mathrm{c\,m}}$, $t_{\mathrm{l\,m}}$, μ, f, α, m_a, m_m, w_m and v are given in the section 3. The thermal and epithermal neutron self-shielding of the lyophilized CSF sample and of the dissolved (and diluted) Co monitor were considered insignificant. Accordingly, $G_{\mathrm{th\,m}} = G_{\mathrm{th\,a}} = G_{\mathrm{e\,m}} = G_{\mathrm{e\,a}} = 1.000$ with negligible uncertainty.

Uncertainty budget

The spreadsheet technique was applied to set up the uncertainty budget of the analyte mass concentration, ρ_a, via the measurement model (5).

The input quantities for ρ_{a} were t_{i}, μ, $t_{1/2\ \mathrm{a}}$, $t_{1/2\ \mathrm{m}}$, $t_{\mathrm{d\ a}}$, $t_{\mathrm{c\ a}}$, $t_{\mathrm{l\ a}}$, $t_{\mathrm{d\ m}}$, $t_{\mathrm{c\ m}}$, $t_{\mathrm{l\ m}}$, $n_{\mathrm{p\ a}}$, $n_{\mathrm{p\ m}}$, $k_{0\ \mathrm{Au}}(\mathrm{a})$, $k_{0\ \mathrm{Au}}(\mathrm{m})$, $G_{\mathrm{th\ a}}$, $G_{\mathrm{e\ a}}$, $G_{\mathrm{th\ m}}$, $G_{\mathrm{e\ m}}$, f, α, $Q_{0\ \mathrm{a}}$, $\bar{E}_{\mathrm{r\ a}}$, $Q_{0\ \mathrm{m}}$, $\bar{E}_{\mathrm{r\ m}}$, $\varepsilon^{\mathrm{geo}}_{\mathrm{p\ m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\ a}}$, $\mathrm{COI_m}/\mathrm{COI_a}$, m_{m}, m_{a}, w_{m} and v. The intermediate quantities λ_{a}, λ_{m}, δ_{a}, δ_{m}, ξ_{a}, ξ_{m}, $Q_{0\ \mathrm{a}}(\alpha)$ and $Q_{0\ \mathrm{m}}(\alpha)$ were calculated for information.

For simplicity, the $\varepsilon^{\mathrm{geo}}_{\mathrm{p\ m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\ a}}$ and $\mathrm{COI_m}/\mathrm{COI_a}$ values and uncertainties were computed separately via the measurement models (7) and (8), respectively. The input quantities for $\varepsilon^{\mathrm{geo}}_{\mathrm{p\ m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\ a}}$ were a_1, a_0, a_{-1}, a_{-2}, a_{-3}, $E_{\gamma\ \mathrm{m}}$, $E_{\gamma\ \mathrm{a}}$, Δd_{a}, Δd_{m}, $\delta\varepsilon_{\mathrm{r\ a}}$ and $\delta\varepsilon_{\mathrm{r\ m}}$ while the input quantities for $\mathrm{COI_m}/\mathrm{COI_a}$ were a_1, a_0, a_{-1}, a_{-2}, a_{-3} and additional parameters depending on the cascade scheme, e.g. E_γ, a_γ, c_γ, P/T and P_γ either for the monitor and for the analyte. The quantities e_4, e_3, e_2, e_1, e_0, d_1 and d_0 used to compute $\delta\varepsilon_{\mathrm{r}}$ and the quantities b_1, b_0, c_2, c_1 and c_0 used to compute P/T were given for information. The (small) correlation effect due to the shared parameters a_1, a_0, a_{-1}, a_{-2} and a_{-3} was neglected.

The formulae were implemented in a MS excel file [17] consisting of nine worksheets, one for each quantified analyte. A single worksheet included four sections. Irradiation time, day and time of the irradiation end, day and time of the γ-counting start, outputs of the Gamma Vision software, target nuclide and produced radionuclide were given in the first section, called “Irradiation and γ-spectrometry”. Values, standard uncertainties and correlation coefficients of the input quantities were added in the main section, called “Uncertainty budget of ρ_{a}”, with the exception of the $\varepsilon^{\mathrm{geo}}_{\mathrm{p\ m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\ a}}$ and $\mathrm{COI_m}/\mathrm{COI_a}$ ratios, whose data were added and calculated in two sub-sections, called “Uncertainty budget of $\varepsilon^{\mathrm{geo}}_{\mathrm{p\ m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\ a}}$” and “Uncertainty budget of $\mathrm{COI_m}/\mathrm{COI_a}$, respectively.

Values and combined uncertainties of ρ_{a}, $\varepsilon^{\mathrm{geo}}_{\mathrm{p\ m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\ a}}$ and $\mathrm{COI_m}/\mathrm{COI_a}$ were calculated together with sensitivity coefficients of the input quantities and their relative contribution; the matrix formalism was used to propagate the uncertainties via the correlation matrices $\boldsymbol{R}_{\rho_{\mathrm{a}}}$, $\boldsymbol{R}_{\varepsilon^{\mathrm{geo}}_{\mathrm{p\ m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\ a}}}$ and $\boldsymbol{R}_{\mathrm{COI_m}/\mathrm{COI_a}}$.

The analysis quantified $2.32(11) \times 10^{-10}$ g mL^{-1} of Th, $2.096(99) \times 10^{-9}$ g mL^{-1} of Cr, $6.89(96) \times 10^{-8}$ g mL^{-1} of Ba, $4.01(39) \times 10^{-11}$ g mL^{-1} of Sb, $5.06(15) \times 10^{-11}$ g mL^{-1} of Sc, 8.00(85) × 10^{-10} g mL^{-1} of Rb, 3.87(27) × 10^{-8} g mL^{-1} of Fe, 2.220(77) × 10^{-8} g mL^{-1} of Zn and 3.24(31) × 10^{-11} g mL^{-1} of Co.

The uncertainty budgets are given in the developed MS excel file available in the Supplementary Information; cells dealing with informative or intermediate data were grayed. In $\boldsymbol{R}_{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$ and $\boldsymbol{R}_{\mathrm{COI_m/COI_a}}$, we set the correlation coefficients of a_1, a_0, a_{-1}, a_{-2} and a_{-3} according to the data shown in Table 1; in addition, as a first attempt, in $\boldsymbol{R}_{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$, we set to the unity value the correlation between $\delta\varepsilon_{\mathrm{r\,a}}$ and $\delta\varepsilon_{\mathrm{r\,m}}$, and in $\boldsymbol{R}_{\mathrm{COI_m/COI_a}}$, we set to the unity value the correlation between P/T_γ values, if existing.

A survey of the main contributors to the combined uncertainties is given in Table 4 while the (complete) Cr budget is shown in the Supplementary Information.

Table 4 Main contributors to the combined uncertainty of the quantified elements. Input quantities, X_i, are explained in the text. The index I is the relative contribution of X_i

Th		Cr		Ba		Sb		Sc		Rb		Fe		Zn		Co	
X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %
$\frac{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}}{\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$	26.7	$n_{\mathrm{p\,a}}$	35.3	$Q_{0\,\mathrm{a}}$	89.3	$n_{\mathrm{p\,a}}$	77.6	$\frac{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}}{\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$	49.3	$n_{\mathrm{p\,a}}$	83.4	$n_{\mathrm{p\,a}}$	78.0	$\frac{\mathrm{COI_m}}{\mathrm{COI_a}}$	33.1	$n_{\mathrm{p\,a}}$	92.8
$n_{\mathrm{p\,a}}$	25.1	$\frac{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}}{\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$	27.4	$\frac{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}}{\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$	3.2	$\frac{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}}{\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$	8.0	v	16.0	$\frac{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}}{\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$	3.5	$\frac{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}}{\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$	7.9	$\frac{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}}{\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$	32.6	$\frac{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}}{\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$	4.1
$\frac{\mathrm{COI_m}}{\mathrm{COI_a}}$	16.1	$\frac{\mathrm{COI_m}}{\mathrm{COI_a}}$	17.6	$n_{\mathrm{p\,a}}$	2.9	$Q_{0\,\mathrm{a}}$	6.6	w_m	10.9	$\frac{\mathrm{COI_m}}{\mathrm{COI_a}}$	3.5	$\frac{\mathrm{COI_m}}{\mathrm{COI_a}}$	6.9	v	12.3		
$Q_{0\,\mathrm{a}}$	12.0	v	6.5					$Q_{0\,\mathrm{a}}$	5.8					w_m	8.4		
v	6.4	w_m	4.5					$n_{\mathrm{p\,a}}$	4.1					$Q_{0\,\mathrm{a}}$	4.1		

In summary, the uncertainty of the results was largely due to $\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}$, $n_{\mathrm{p\,a}}$ and $\mathrm{COI_m/COI_a}$. In a few cases, v, w_m and m_m had an influence while the 20% uncertainty of the $Q_{0\,\mathrm{a}}$ recommended in the k_0 database [14] had the overriding effect for the determination of Ba.

It is worth to observe that the contribution to $\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}$ due to possible differences in counting positions of samples could be canceled if the monitor element was embedded in the analyte sample [18, 19]; this was confirmed by setting the correlation coefficient between Δd_a and Δd_m in $\boldsymbol{R}_{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$ to the unity value.

Besides, the result of Co deserves attention. In this case, i.e. when the analyte corresponds to the monitor element and the same γ-emission is used, the k_0-NAA turns into the relative-NAA. Accordingly, we set to the unity value the correlation coefficients between $t_{1/2}$, $t_{1/2}$, $k_{0\,\mathrm{Au}}$, Q_0 and $\bar{E}_\mathrm{r}$ in $\boldsymbol{R}_{\rho_\mathrm{a}}$ and between E_γ, a_γ, c_γ, P/T_γ in $\boldsymbol{R}_{\mathrm{COI_m/COI_a}}$. As a result, the contributions due to the "intrinsic" uncertainty characteristic of the k_0-NAA method [8] and due to the $\mathrm{COI_m}/\mathrm{COI_a}$ were reset; moreover, the correlation coefficients of a_1, a_0, a_{-1}, a_{-2} and a_{-3} in $\boldsymbol{R}_{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$ made their contribution to $\varepsilon_{\mathrm{p\,m}}^{\mathrm{ext}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{ext}}$ zero as well.

Conclusions

The spreadsheet approach proved to be suitable to set up the uncertainty budget for the k_0-standardisation method in NAA when the majority of the recognized sources of error are considered and the measurement model is written to limit the correlations between input quantities. The use of the matrix formalism was straightforward to propagate the uncertainties by taking into account the covariances.

A MS excel file was developed and tested for the determination of Th, Cr, Ba, Sb, Sc, Rb, Fe, Zn and Co in a lyophilized CSF sample. The uncertainty budget of each element was compiled once the estimates, the uncertainties and the correlation coefficients associated with the input quantities were specified. The value and combined uncertainty of the result were calculated and the most overriding contributors were pointed out.

It was shown that when the monitor element corresponded to the analyte element and the same γ-emission was used, the worksheet set up the uncertainty budget for the relative-NAA method; this makes the proposed approach applicable either in the relative- and k_0-NAA.

The MS excel file is open and free available to users. The implemented measurement model allows a broad application, e.g. in case of different sample material, monitor element, neutron irradiation and γ-spectrometry conditions. The extension to other elements is possible by a simple duplication of the existing worksheets; only the modification of the formulae adopted to compute the $\mathrm{COI_m/COI_a}$ ratio might be required for other decay schemes.

References

1. EURACHEM/CITAC Guide 3rd Ed. (2012) Quantifying Uncertainty in Analytical Measurement

2. Guide to the Expression of Uncertainty in Measurement (1993), International Organization for Standardisation (ISO), Geneva

3. Quantifying Uncertainty in Nuclear Analytical Measurements (2004), International Atomic Energy Agency

4. de Corte F (1987) The k_0-standardisation, a move to the optimization of neutron activation analysis. Habilitation Thesis, University of Gent, Belgium

5. Robouch P, Arana G, Eguskiza M, Pommé S, Etxebarria N (2000) Uncertainty budget for k_0-NAA. J Radioanal Nucl Chem. 245:195-197

6. Kragten J (1994) Calculating standard deviations and confidence intervals with a universally applicable spreadsheet technique. Analyst. 119:2161-2165

7. Younes N, Robouch P (2003) A web tool for calculating k_0-NAA uncertainties. J Radioanal Nucl Chem. 257:665-667

8. Bucar T, Smodis B (2006) Assessment of the intrinsic uncertainty of the k_0-based NAA. Nucl Instr Meth Phys Res A. 564:683-687

9. Smodis B, Bucar T (2006) Overall measurement uncertainty of k_0-based neutron activation analysis. J Radioanal Nucl Chem. 269:311-316

10. Simonits A, de Corte F, Hoste J (1975) Single-comparator methods in reactor neutron activation analysis. J Radioanal Chem. 24:31-46

11. Girardi F, Guzzi G, Pauly J (1965) Reactor neutron activation analysis by the single comparator method. Anal Chem. 37:1085-1092

12. Høgdahl OT (1965) In: Proc. Symp. Radiochemical Methods of Analysis, Salzburg, 19-23 October, 1964, IAEA, Vienna, p. 23

13. D'Agostino G, Di Luzio M, Mana G, Oddone M (2017) A new low-uncertainty measurement of the ^{31}Si half-life. Metrologia. 54:410-416

14. k_0-International Scientific Committee, Database of Recommended k_0-Data, released January 11, 2016 http://www.kayzero.com/k0naa/k0naaorg/Nuclear_Data_SC/Entries/2016/1/11_New_k0-data_Library_2015.html

15. Di Luzio M, Oddone M, Prata M, Alloni D, D'Agostino G (2017) Measurement of the neutron flux parameters f and α at the Pavia TRIGA Mark II reactor. J Radioanal Nucl Chem. 312:75-80

16. Moens L, De Donder J, Xilei L, de Corte F, De Wispelaere A, Simonits A, Hoste J (1981) Calculation of the absolute peak efficiency of gamma-ray detectors for different counting geometries. Nucl Instr Methods Phys Res. 187:451-471

17. Microsoft Excel 2013, Microsoft Corporation, Redmond, Washington, US

18. Acharya R, Nair AGC, Sudarshan K, Reddy AVR, Goswami A (2007) Development and applications of the k_0-based internal mono standard INAA method. Appl Rad and Isot. 65:164-169

19. D'Agostino G, Di Luzio M, Mana G, Martino L, Oddone M, Sasso C (2016) Quantification of the void volume in single-crystal silicon. Anal Chem. 88:11678-11683

Supplementary information

Developed worksheet file

See the MS excel file “uncertainty_k0_spreadsheet.xlsx”

Uncertainty budget of Cr

The (complete) uncertainty budget of the Cr determination is here reported. According to Table 1, the most overriding contributors to the combined uncertainty were $n_{\mathrm{p\,a}}$ (35.3%), $\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}$ (27.4%) and $\mathrm{COI_m}/\mathrm{COI_a}$ (17.6%). The remaining 19.7% was due to v, w_{m}, $Q_{0\,\mathrm{a}}$,m_{m}, $k_{0\,\mathrm{Au}}(\mathrm{a})$, $k_{0\,\mathrm{Au}}(\mathrm{m})$, $Q_{0\,\mathrm{m}}$, $n_{\mathrm{p\,m}}$, α and f, in decreasing order of importance. As regards to $\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}$ (see Table 2), the main contributors were a_1, a_{-1}, a_{-2} (44.0%), Δd_{a} (25.6%) and Δd_{m} (31.5%), while the uncertainty of $\mathrm{COI_m}/\mathrm{COI_a}$ (see Table 3) was due to $P/T_{\gamma 2\,\mathrm{m}}$ (96.1%).

The a_0 value is not affecting $\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}$. In fact, a_0 in equation (6) models a constant multiplying factor that is deleted from the detection efficiency ratio. In addition, since we considered $\Delta d_{\mathrm{a}} = \Delta d_{\mathrm{m}} = 0$ mm, the contribution of $\delta\varepsilon_{\mathrm{r\,a}}$ and $\delta\varepsilon_{\mathrm{r\,m}}$ was reset.

Table 1 Uncertainty budget of the mass concentration of Cr in the lyophilized CSF sample. Quantities are explained in the text. The column Index gives the relative contribution of the input quantity, X_{i}, to the output quantity, Y. Values of the sensitivity coefficient, c_{i}, and Index are omitted for those quantities that are not actual inputs of the measurement model.

Quantity X_{i}	Unit $[X_{\mathrm{i}}]$	Value x_{i}	Std. Uncertainty $u(x_{\mathrm{i}})$	Sens. Coeff. c_{i}	Index I / %
t_{i}	s	2.1600×10^{4}	1.7×10^{1}	3.0×10^{-16}	0.0
μ	1	4.45×10^{-2}	5×10^{-4}	-1.0×10^{-10}	0.0
$t_{1/2\,\mathrm{a}}$	s	2.39328×10^{6}	2.1×10^{2}	1.1×10^{-16}	0.0
λ_{a}	s^{-1}	2.89622×10^{-7}	2.5×10^{-11}		
$t_{1/2\,\mathrm{m}}$	s	1.66346×10^{8}	2.6×10^{4}	-1.2×10^{-17}	0.0
λ_{m}	s^{-1}	4.16690×10^{-9}	6.5×10^{-13}		
$t_{\mathrm{d\,a}}$	s	2.404405×10^{6}	3.5×10^{1}	6.1×10^{-16}	0.0

$t_{\mathrm{c\ a}}$	s	1.29262800 × 10^{6}	2.9 × 10^{-1}	3.6 × 10^{-16}	0.0
$t_{\mathrm{l\ a}}$	s	1.26426800 × 10^{6}	2.9 × 10^{-1}	-1.7 × 10^{-15}	0.0
$t_{\mathrm{d\ m}}$	s	3.722775 × 10^{6}	3.5 × 10^{1}	-8.7 × 10^{-18}	0.0
$t_{\mathrm{c\ m}}$	s	7.9700 × 10^{2}	2.9 × 10^{-1}	-1.1 × 10^{-13}	0.0
$t_{\mathrm{l\ m}}$	s	7.400 × 10^{2}	2.9 × 10^{-1}	2.9 × 10^{-12}	0.0
δ_{a}	1	1.022	0.000		
δ_{m}	1	1.077	0.001		
ξ_{a}	1	1.00098	1 × 10^{-5}		
ξ_{m}	1	1.00319	4 × 10^{-5}		
$n_{\mathrm{p\ a}}$	1	5.26 × 10^{4}	1.5 × 10^{3}	4.0 × 10^{-14}	35.3
$n_{\mathrm{p\ m}}$	1	1.3749 × 10^{5}	4.4 × 10^{2}	-1.5 × 10^{-14}	0.5
$k_{0\ \mathrm{Au}}(\mathrm{a})$	1	2.620 × 10^{-3}	1.3 × 10^{-5}	-8.0 × 10^{-7}	1.1
$k_{0\ \mathrm{Au}}(\mathrm{m})$	1	1.3200	5.3 × 10^{-3}	1.6 × 10^{-9}	0.7
$G_{\mathrm{th\ a}}$	1	1.000	0.000	-2.0 × 10^{-9}	0.0
$G_{\mathrm{e\ a}}$	1	1.000	0.000	-7.7 × 10^{-11}	0.0
$G_{\mathrm{th\ m}}$	1	1.000	0.000	1.8 × 10^{-9}	0.0
$G_{\mathrm{e\ m}}$	1	1.000	0.000	2.7 × 10^{-10}	0.0
f	1	1.560 × 10^{1}	3.3 × 10^{-1}	-1.2 × 10^{-11}	0.2
α	1	-3.60 × 10^{-2}	6.4 × 10^{-3}	-9.0 × 10^{-10}	0.3
$Q_{0\ \mathrm{a}}$	1	5.3 × 10^{-1}	1.1 × 10^{-1}	-1.8 × 10^{-10}	3.6
$\bar{E}_{\mathrm{r\ a}}$	eV	7.53 × 10^{3}	8.3 × 10^{2}	-8.7 × 10^{-17}	0.0
$Q_{0\ \mathrm{a}}(\alpha)$	1	5.9 × 10^{-1}	1.5 × 10^{-1}		
$Q_{0\ \mathrm{m}}$	1	1.993	6.0 × 10^{-2}	1.4 × 10^{-10}	0.7
$\bar{E}_{\mathrm{r\ m}}$	eV	1.360 × 10^{2}	6.9	5.8 × 10^{-14}	0.0
$Q_{0\ \mathrm{m}}(\alpha)$	1	2.319	9.5 × 10^{-2}		
$\varepsilon_{\mathrm{p\ m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\ a}}^{\mathrm{geo}}$	1	3.507 × 10^{-1}	8.7 × 10^{-3}	6.0 × 10^{-9}	27.4
$\mathrm{COI_m}/\mathrm{COI_a}$	1	8.57 × 10^{-1}	1.7 × 10^{-2}	2.4 × 10^{-9}	17.6
m_{m}	g	8.47 × 10^{-3}	5 × 10^{-5}	2.5 × 10^{-7}	1.6
m_{a}	g	2.4000 × 10^{-1}	5 × 10^{-5}	-8.7 × 10^{-9}	0.0
w_{m}	g g^{-1}	4.597 × 10^{-3}	4.6 × 10^{-5}	4.6 × 10^{-7}	4.5
v	mg L^{-1}	99.2	1.2	-2.1 × 10^{-11}	6.6
Y	$[Y]$	y	$u_{\mathrm{c}}(y)$		
ρ_{a}	g mL^{-1}	2.096 × 10^{-9}	9.9 × 10^{-11}		

Table 2. Uncertainty budget of the $\varepsilon_{\mathrm{p\ m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\ a}}^{\mathrm{geo}}$ ratio given in Table 1.

Quantity X_{i}	Unit $[X_{\mathrm{i}}]$	Value x_{i}	Std. Uncertainty $u(x_{\mathrm{i}})$	Sens. Coeff. c_{i}	Index I / %
a_1	MeV^{-1}	-4.72 × 10^{-1}	4.3 × 10^{-2}	3.0 × 10^{-1}	74.1

a_0	1	-3.229	5.7 × 10^{-2}	0.0	0.0
a_{-1}	MeV	4.03 × 10^{-1}	2.0 × 10^{-2}	-8.0 × 10^{-1}	-43.1
a_{-2}	MeV^2	3.20 × 10^{-2}	2.2 × 10^{-3}	-3.2	13.0
a_{-3}	MeV^3	5.73 × 10^{-4}	7.5 × 10^{-5}	-1.0 × 10^1	-1.1
$E_{\gamma\,m}$	MeV	1.17320	1.2 × 10^{-4}	-2.5 × 10^{-1}	0.0
$E_{\gamma\,a}$	MeV	3.2010 × 10^{-1}	1.2 × 10^{-4}	9.2 × 10^{-1}	0.0
Δd_a	mm	0.00	0.29	1.5 × 10^{-2}	25.6
Δd_m	mm	0.00	0.29	-1.7 × 10^{-2}	31.5
e_4	keV^{-4}	-7.10 × 10^{-11}	0.00 × 10^{-11}		
e_3	keV^{-3}	5.19 × 10^{-8}	0.00 × 10^{-8}		
e_2	keV^{-2}	-1.43 × 10^{-5}	0.00 × 10^{-5}		
e_1	keV^{-1}	1.78 × 10^{-3}	0.00 × 10^{-3}		
e_0	1	-4.46 × 10^{-2}	0.00 × 10^{-2}		
d_1	keV^{-1}	5.56 × 10^{-6}	0.00 × 10^{-6}		
d_0	1	4.17 × 10^{-2}	0.00 × 10^{-2}		
$\delta\varepsilon_{r\,a}$	mm^{-1}	4.3 × 10^{-2}	5 × 10^{-3}	0.0	0.0
$\delta\varepsilon_{r\,m}$	mm^{-1}	4.8 × 10^{-2}	6 × 10^{-3}	0.0	0.0
Y	$[Y]$	y	$u_c(y)$		
$\varepsilon_{p\,m}^{geo}/\varepsilon_{p\,a}^{geo}$	1	3.507 × 10^{-1}	8.7 × 10^{-3}		

Table 3 Uncertainty budget of the COI_m/COI_a ratio given in Table 1. (*) Notation reported in [4] and adopted for the cascade scheme.

Quantity X_i	Unit $[X_i]$	Value x_i	Std. Uncertainty $u(x_i)$	Sens. Coeff. c_i	Index I / %
a_1	MeV^{-1}	-4.72 × 10^{-1}	4.3 × 10^{-2}	-1.9 × 10^{-1}	5.9
a_0	1	-3.229	5.7 × 10^{-2}	-1.4 × 10^{-1}	-4.9
a_{-1}	MeV	4.03 × 10^{-1}	2.0 × 10^{-2}	-1.1 × 10^{-1}	1.0
a_{-2}	MeV^2	3.20 × 10^{-2}	2.2 × 10^{-3}	-8.0 × 10^{-2}	-0.1
a_{-3}	MeV^3	5.73 × 10^{-4}	7.5 × 10^{-5}	-6.0 × 10^{-2}	0.0
b_1	1	-0.571	0.000		
b_0	1	1.079	0.000		
c_2	1	-1.625	0.000		
c_1	1	6.678	0.000		
c_0	1	-7.006	0.000		
$E_{\gamma 2\,m}$	keV	1.3325 × 10^3	1.2 × 10^{-1}	9.6 × 10^{-5}	0.0
$a_{\gamma 2\,m}$	1	1.000	0.012	-1.4 × 10^{-1}	0.9
$c_{\gamma 2\,m}$	1	1.000	0.012	-1.4 × 10^{-1}	0.9
$P/T_{\gamma 2\,m}$	1	0.197	0.023	7.3 × 10^{-1}	96.1

Y	$[Y]$	y	$u_c(y)$		
COI_m/COI_a	1	8.57×10^{-1}	1.7×10^{-2}		

This section will not appear in the printed version of your paper but it will contain a link; the webpage containing the electronic supplementary information will appear when one clicks on the hyperlink. Here you can list the details of your research which would be too long for the main text, *e.g.* a larger number of spectra *etc*. Start with 1 for Figure and Table numbers in this section.

Irradiation and γ-spectrometry

end irradiation		9/12/2017	2.46 PM
irradiation time / s		21600	

library	CSF.Lib
calib	OR50_source2016_geom_cont_12052017.Clb
sm type	CSF.Lib (ROI32 Analysis)

Nuclide	Channel	Energy	Background
233Pa	1246.2	311.9	1461015
Co60	4691.96	1173.2	5220

	target	product
analite, a	^{232}Th	^{233}Pa
monitor, m	^{59}Co	^{60}Co

Uncertainty budget of ρ_a

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
t_i		s	21600
μ		1	0.0445
$t_{1/2\ a}$		s	2330208
	λ_a	s^{-1}	3.0E-07
$t_{1/2\ m}$		s	1.7E+08
	λ_m	s^{-1}	4.2E-09
$t_{d\ a}$		s	2404405
$t_{c\ a}$		s	1292628
$t_{l\ a}$		s	1264268
$t_{d\ m}$		s	3722775
$t_{c\ m}$		s	797.0
$t_{l\ m}$		s	740.0
	δ_a	1	1.022
	δ_m	1	1.077
	ξ_a	1	1.001
	ξ_m	1	1.003
$n_{p\ a}$		1	101680
$n_{p\ m}$		1	137487
$k_{0\ Au}(a)$		1	0.02520
$k_{0\ Au}(m)$		1	1.3200
$G_{th\ a}$		1	1

$G_{e\ a}$		1	1
$G_{th\ m}$		1	1
$G_{e\ m}$		1	1
f		1	15.60
α		1	-0.0360
$Q_{0\ a}$		1	11.50
$E_{r\ a}$		eV	54.40
	$Q_{0\ a}(\alpha)$	1	13.24
$Q_{0\ m}$		1	1.993
$E_{r\ m}$		eV	136.0
	$Q_{0\ m}(\alpha)$	1	2.319
$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$		1	0.3431
COI_m / COI_a		1	0.862
m_m		g	0.00847
m_a		g	0.24000
w_m		$g\ g^{-1}$	0.004597
υ		$mg\ L^{-1}$	99.2
Y		[Y]	y
ρ_a		$g\ mL^{-1}$	2.32E-10

Uncertainty budget of $\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$

Input Quantity X_i	Quantity X_i	Unit $[X_i]$	Value x_i
a_1		Mev-1	-0.472
a_0		1	-3.229
a_{-1}		Mev	0.403
a_{-2}		Mev2	-0.0320
a_{-3}		Mev3	0.000573
$E_{\gamma\ m}$		MeV	1.17320
$E_{\gamma\ a}$		MeV	0.31190
Δd_a		mm	0
Δd_m		mm	0
	e_4	keV-4	-7.1E-11
	e_3	keV-3	5.2E-08
	e_2	keV-2	-1.4E-05
	e_1	keV-1	1.8E-03
	e_0	1	-4.5E-02
	d_1	keV-1	5.6E-06

	d_0	1	4.2E-02
$\delta\varepsilon_{r\,a}$		mm^{-1}	0.043
$\delta\varepsilon_{r\,m}$		mm^{-1}	0.048

Y	[Y]	y
$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	1	0.343

Uncertainty budget of COI_m / COI_a

Input Quantity	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
a_1		Mev-1	-0.472
a_0		1	-3.229
a_{-1}		Mev	0.403
a_{-2}		Mev2	-0.0320
a_{-3}		Mev3	0.000573
	b_1	1	-0.571
	b_0	1	1.079
	c_2	1	-1.625
	c_1	1	6.678
	c_0	1	-7.006
$E_{\gamma 2\,m}$		keV	1332.50
$a_{\gamma 2\,m}$		1	1.000
$c_{\gamma 2\,m}$		1	1.000
$P/T_{\gamma 2\,m}$		1	0.197
$E_{\gamma 6\,a}$		keV	86.60
$P_{\gamma 6\,a}$		1	2.05%
$P/T_{\gamma 6\,a}$		1	0.680
$a_{\gamma 9\,a}$		1	0.980
$c_{\gamma 9\,a}$		1	0.550
$P_{\gamma 9\,a}$		1	38.60%

Y	[Y]	y
COI_m / COI_a	1	0.862

Net area	Cnts/s	Uncert %	FWHM	source file	start counting
101680	0.08	2.4	1.269	OR50_20171025_CSF_sa	10/10/2017
137487	185.919	0.32	1.798	OR50_20170925_Co_sa	10/25/2017

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
17	0.1%	3.4E-17	3.5E-31	0.0%	2.2E+04	2.3E-10
0.0005	1.1%	-1.1E-11	3.3E-29	0.0%	4.5E-02	2.3E-10
173	0.0%	1.0E-17	3.1E-30	0.0%	2.3E+06	2.3E-10
2.2E-11	0.0%					
2.6E+04	0.0%	-1.4E-18	1.3E-27	0.0%	1.7E+08	2.3E-10
6.5E-13	0.0%					
35	0.0%	6.9E-17	5.7E-30	0.0%	2.4E+06	2.3E-10
0.3	0.0%	4.0E-17	1.3E-34	0.0%	1.3E+06	2.3E-10
0.3	0.0%	-1.9E-16	3.1E-33	0.0%	1.3E+06	2.3E-10
35	0.0%	-9.7E-19	1.1E-33	0.0%	3.7E+06	2.3E-10
0.3	0.0%	-1.2E-14	1.2E-29	0.0%	8.0E+02	2.3E-10
0.3	0.0%	3.3E-13	8.9E-27	0.0%	7.4E+02	2.3E-10
0.000	0.0%					
0.001	0.1%					
0.000	0.0%					
0.000	0.0%					
2440	2.4%	2.3E-15	3.1E-23	25.1%	1.0E+05	2.4E-10
440	0.3%	-1.7E-15	5.5E-25	0.4%	1.4E+05	2.3E-10
0.00013	0.5%	-9.2E-09	1.3E-24	1.1%	2.5E-02	2.3E-10
0.0053	0.4%	1.8E-10	8.6E-25	0.7%	1.3E+00	2.3E-10
0	0.0%	-1.3E-10	0.0E+00	0.0%	1.0E+00	2.3E-10

0	0.0%	-1.1E-10	0.0E+00	0.0%	1.0E+00	2.3E-10
0	0.0%	2.0E-10	0.0E+00	0.0%	1.0E+00	2.3E-10
0	0.0%	3.0E-11	0.0E+00	0.0%	1.0E+00	2.3E-10
0.33	2.1%	4.9E-12	2.6E-24	2.1%	1.6E+01	2.3E-10
0.0064	17.8%	2.9E-10	3.4E-24	2.8%	-3.0E-02	2.3E-10
0.41	3.6%	-9.3E-12	1.5E-23	12.0%	1.2E+01	2.3E-10
0.49	0.9%	-6.8E-14	1.1E-27	0.0%	5.5E+01	2.3E-10
0.58	4.4%					
0.060	3.0%	1.5E-11	8.5E-25	0.7%	2.1E+00	2.3E-10
6.9	5.1%	6.4E-15	2.0E-27	0.0%	1.4E+02	2.3E-10
0.095	4.1%					
0.0085	2.5%	6.8E-10	3.3E-23	26.7%	3.5E-01	2.4E-10
0.017	1.9%	2.7E-10	2.0E-23	16.1%	8.8E-01	2.4E-10
0.00005	0.6%	2.7E-08	1.9E-24	1.5%	8.5E-03	2.3E-10
0.00005	0.0%	-9.7E-10	2.3E-27	0.0%	2.4E-01	2.3E-10
0.000046	1.0%	5.0E-08	5.4E-24	4.4%	4.6E-03	2.3E-10
1.2	1.2%	-2.3E-12	7.9E-24	6.4%	1.0E+02	2.3E-10
$u_c(y)$	$u_{c\,r}(y)$			Σ		
1.1E-11	4.8%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	3.0E-01	5.3E-05	73.4%	-4.3E-01	3.6E-01
0.057	1.8%	0.0E+00	0.0E+00	0.0%	-3.2E+00	3.4E-01
0.020	4.8%	-8.1E-01	-3.1E-05	-42.4%	4.2E-01	3.3E-01
0.0022	6.9%	-3.3E+00	9.1E-06	12.6%	-3.0E-02	3.4E-01
0.000075	13.1%	-1.1E+01	-7.5E-07	-1.0%	6.5E-04	3.4E-01
0.00012	0.0%	-2.5E-01	8.3E-10	0.0%	1.2E+00	3.4E-01
0.00012	0.0%	9.2E-01	1.1E-08	0.0%	3.1E-01	3.4E-01
0.29		1.5E-02	1.8E-05	25.7%	2.9E-01	3.5E-01
0.29		-1.7E-02	2.3E-05	31.7%	2.9E-01	3.4E-01
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					

0.0000	0.0%					
0.005	11.5%	0.0E+00	0.0E+00	0.0%	4.8E-02	3.4E-01
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.4E-02	3.4E-01
$u_c(y)$	$u_{c\,r}(y)$			Σ		
0.008	2.5%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	-0.1908	1.7E-05	6.3%	-4.3E-01	8.5E-01
0.057	1.8%	-0.1385	-1.4E-05	-5.2%	-3.2E+00	8.5E-01
0.020	4.8%	-0.0496	1.4E-06	0.5%	4.2E-01	8.6E-01
0.0022	6.9%	0.5942	1.7E-06	0.6%	-3.0E-02	8.6E-01
0.000075	13.1%	7.6348	-6.7E-07	-0.2%	6.5E-04	8.6E-01
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0.12	0.0%	0.0001	1.2E-10	0.0%	1.3E+03	8.6E-01
0.012	1.2%	-0.1434	2.7E-06	1.0%	1.0E+00	8.6E-01
0.012	1.2%	-0.1434	2.7E-06	1.0%	1.0E+00	8.6E-01
0.023	11.5%	0.7385	2.7E-04	99.4%	2.2E-01	8.8E-01
0.12	0.1%	0.0001	6.1E-11	0.0%	8.7E+01	8.6E-01
0.01%	0.6%	0.2432	7.9E-10	0.0%	2.1E-02	8.6E-01
0.079	11.5%	-0.0074	-9.5E-06	-3.5%	7.6E-01	8.6E-01
0.012	1.2%	0.0051	3.5E-09	0.0%	9.9E-01	8.6E-01
0.012	2.1%	0.0091	1.1E-08	0.0%	5.6E-01	8.6E-01
0.12%	0.3%	-0.0129	2.2E-10	0.0%	3.9E-01	8.6E-01
$u_c(y)$	$u_r(y)$			Σ		
0.017	1.9%			100.0%		

	t_c / s	t_l / s	$t_{dead\ r}$ / %	t_d / s	$t_c / t_{1/2}$	$t_d / t_{1/2}$
10:39 AM	1292628	1264268	2.2%	2404405	0.55	1.0
4:52 PM	797	740	7.2%	3722775	0.00	0.0

Correlation matrix of ρ_a

x_i-u(x_i)	y(x_i-u(x_i))		t_i	μ	$t_{1/2\ a}$	$t_{1/2\ m}$
2.2E+04	2.3E-10	t_i	1	0	0	0
4.4E-02	2.3E-10	μ	0	1	0	0
2.3E+06	2.3E-10	$t_{1/2\ a}$	0	0	1	0
		$t_{1/2\ m}$	0	0	0	1
1.7E+08	2.3E-10	$t_{d\ a}$	0	0	0	0
		$t_{c\ a}$	0	0	0	0
2.4E+06	2.3E-10	$t_{l\ a}$	0	0	0	0
1.3E+06	2.3E-10	$t_{d\ m}$	0	0	0	0
1.3E+06	2.3E-10	$t_{c\ m}$	0	0	0	0
3.7E+06	2.3E-10	$t_{l\ m}$	0	0	0	0
8.0E+02	2.3E-10	$n_{p\ a}$	0	0	0	0
7.4E+02	2.3E-10	$n_{p\ m}$	0	0	0	0
		$k_{0\ Au}$(a)	0	0	0	0
		$k_{0\ Au}$(m)	0	0	0	0
		$G_{th\ a}$	0	0	0	0
		$G_{e\ a}$	0	0	0	0
9.9E+04	2.3E-10	$G_{th\ m}$	0	0	0	0
1.4E+05	2.3E-10	$G_{e\ m}$	0	0	0	0
2.5E-02	2.3E-10	f	0	0	0	0
1.3E+00	2.3E-10	α	0	0	0	0
1.0E+00	2.3E-10	$Q_{0\ a}$	0	0	0	0

1.0E+00	2.3E-10	$E_{r\,a}$	0	0	0	0
1.0E+00	2.3E-10	$Q_{0\,m}$	0	0	0	0
1.0E+00	2.3E-10	$E_{r\,m}$	0	0	0	0
1.5E+01	2.3E-10	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}$	0	0	0	0
-4.2E-02	2.3E-10	COI_m / COI_a	0	0	0	0
1.1E+01	2.4E-10	m_m	0	0	0	0
5.4E+01	2.3E-10	m_a	0	0	0	0
		w_m	0	0	0	0
1.9E+00	2.3E-10	υ	0	0	0	0
1.3E+02	2.3E-10					
3.3E-01	2.3E-10					
8.5E-01	2.3E-10					
8.4E-03	2.3E-10					
2.4E-01	2.3E-10					
4.6E-03	2.3E-10					
9.8E+01	2.3E-10					

Correlation matrix of $\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$

x_i-u(x_i)	y(x_i-u(x_i))		a_1	a_0	a_{-1}	a_{-2}
-5.2E-01	3.3E-01	a_1	1.000	-0.973	0.884	-0.804
-3.3E+00	3.4E-01	a_0	-0.973	1.000	-0.957	0.896
3.8E-01	3.6E-01	a_{-1}	0.884	-0.957	1.000	-0.984
-3.4E-02	3.5E-01	a_{-2}	-0.804	0.896	-0.984	1.000
5.0E-04	3.4E-01	a_{-3}	0.748	-0.848	0.957	-0.993
1.2E+00	3.4E-01	$E_{\gamma\,m}$	0	0	0	0
3.1E-01	3.4E-01	$E_{\gamma\,a}$	0	0	0	0
-2.9E-01	3.4E-01	Δd_a	0	0	0	0
-2.9E-01	3.5E-01	Δd_m	0	0	0	0
		$\delta\varepsilon_{r\,a}$	0	0	0	0
		$\delta\varepsilon_{r\,m}$	0	0	0	0

3.8E-02	3.4E-01
4.3E-02	3.4E-01

Correlation matrix of COI_m / COI_a

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	8.7E-01
-3.3E+00	8.7E-01
3.8E-01	8.6E-01
-3.4E-02	8.6E-01
5.0E-04	8.6E-01
1.3E+03	8.6E-01
9.9E-01	8.6E-01
9.9E-01	8.6E-01
1.7E-01	8.4E-01
8.6E+01	8.6E-01
2.0E-02	8.6E-01
6.0E-01	8.6E-01
9.7E-01	8.6E-01
5.4E-01	8.6E-01
3.8E-01	8.6E-01

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma 2\ m}$	0	0	0	0
$a_{\gamma 2\ m}$	0	0	0	0
$c_{\gamma 2\ m}$	0	0	0	0
$P/T_{\gamma 2\ m}$	0	0	0	0
$E_{\gamma 6\ a}$	0	0	0	0
$P_{\gamma 6\ a}$	0	0	0	0
$P/T_{\gamma 6\ a}$	0	0	0	0
$a_{\gamma 9\ a}$	0	0	0	0
$c_{\gamma 9\ a}$	0	0	0	0
$P_{\gamma 9\ a}$	0	0	0	0

$t_{d\,a}$	$t_{c\,a}$	$t_{l\,a}$	$t_{d\,m}$	$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

a_{-3}	$E_{\gamma m}$	$E_{\gamma a}$	Δd_a	Δd_m	$\delta\varepsilon_{r a}$	$\delta\varepsilon_{r m}$	c_i
0.748	0	0	0	0	0	0	3.0E-01
-0.848	0	0	0	0	0	0	0.0E+00
0.957	0	0	0	0	0	0	-8.1E-01
-0.993	0	0	0	0	0	0	-3.3E+00
1.000	0	0	0	0	0	0	-1.1E+01
0	1	0	0	0	0	0	-2.5E-01
0	0	1	0	0	0	0	9.2E-01
0	0	0	1	0	0	0	1.5E-02
0	0	0	0	1	0	0	-1.7E-02
0	0	0	0	0	1	1	0.0E+00
0	0	0	0	0	1	1	0.0E+00

a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	$E_{\gamma 6\ a}$	$P_{\gamma 6\ a}$	$P/T_{\gamma 6\ a}$	$a_{\gamma 9\ a}$
0.748	0	0	0	0	0	0	0	0
-0.848	0	0	0	0	0	0	0	0
0.957	0	0	0	0	0	0	0	0
-0.993	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	1	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	1	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

$k_{0\,Au}(m)$	$G_{th\,a}$	$G_{e\,a}$	$G_{th\,m}$	$G_{e\,m}$	f	α	$Q_{0\,a}$	$E_{r\,a}$	
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0
	0	1	0	0	0	0	0	0	0
	0	0	1	0	0	0	0	0	0
	0	0	0	1	0	0	0	0	0
	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	1	0	0	0
	0	0	0	0	0	0	1	0	0
	0	0	0	0	0	0	0	1	0

0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Covariance matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

	a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma\,m}$	$E_{\gamma\,a}$
a_1	1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00
a_0	-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00
a_{-1}	7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00
a_{-3}	2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00
$E_{\gamma\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08	0.0E+00
$E_{\gamma\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08
Δd_a	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Δd_m	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
c_i	3.0E-01	0.0E+00	-8.1E-01	-3.3E+00	-1.1E+01	-2.5E-01	9.2E-01

$c_{\gamma 9\ a}$	$P_{\gamma 9\ a}$	c_i
0	0	-1.9E-01
0	0	-1.4E-01
0	0	-5.0E-02
0	0	5.9E-01
0	0	7.6E+00
0	0	9.7E-05
0	0	-1.4E-01
0	0	-1.4E-01
0	0	7.4E-01
0	0	6.8E-05
0	0	2.4E-01
0	0	-7.4E-03
0	0	5.1E-03
1	0	9.1E-03
0	1	-1.3E-02

Covariance matrix of COI_m/COI_a

	a_1	a_0	a_{-1}
a_1	1.9E-03	-2.4E-03	7.5E-04
a_0	-2.4E-03	3.2E-03	-1.1E-03
a_{-1}	7.5E-04	-1.1E-03	3.8E-04
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05
a_{-3}	2.4E-06	-3.6E-06	1.4E-06
$E_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$a_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$c_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$P/T_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$E_{\gamma 6\ a}$	0.0E+00	0.0E+00	0.0E+00
$P_{\gamma 6\ a}$	0.0E+00	0.0E+00	0.0E+00
$P/T_{\gamma 6\ a}$	0.0E+00	0.0E+00	0.0E+00
$a_{\gamma 9\ a}$	0.0E+00	0.0E+00	0.0E+00
$c_{\gamma 9\ a}$	0.0E+00	0.0E+00	0.0E+00
$P_{\gamma 9\ a}$	0.0E+00	0.0E+00	0.0E+00
c_i	-1.9E-01	-1.4E-01	-5.0E-02

$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	COI_m / COI_a	m_m	m_a	w_m
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

0	0	0	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	1	0	0	0	0
0	0	0	1	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	1	0
0	0	0	0	0	0	1
0	0	0	0	0	0	0

Δd_a	Δd_m	$\delta \varepsilon_{r\,a}$	$\delta \varepsilon_{r\,m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.5E-05	2.8E-05
0.0E+00	0.0E+00	2.8E-05	3.1E-05
1.5E-02	-1.7E-02	0.0E+00	0.0E+00

a_{-2}	a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	$E_{\gamma 6\ a}$
-7.7E-05	2.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.1E-04	-3.6E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-4.3E-05	1.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.9E-06	-1.7E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.7E-07	5.7E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-02
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E-03	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
5.9E-01	7.6E+00	9.7E-05	-1.4E-01	-1.4E-01	7.4E-01	6.8E-05

Covariance matrix of ρ_a

υ	c_i		t_i	μ
0	3.4E-17	t_i	3.0E+02	0.0E+00
0	-1.1E-11	μ	0.0E+00	2.5E-07
0	1.0E-17	$t_{1/2\ a}$	0.0E+00	0.0E+00
0	-1.4E-18	$t_{1/2\ m}$	0.0E+00	0.0E+00
0	6.9E-17	$t_{d\ a}$	0.0E+00	0.0E+00
0	4.0E-17	$t_{c\ a}$	0.0E+00	0.0E+00
0	-1.9E-16	$t_{l\ a}$	0.0E+00	0.0E+00
0	-9.7E-19	$t_{d\ m}$	0.0E+00	0.0E+00
0	-1.2E-14	$t_{c\ m}$	0.0E+00	0.0E+00
0	3.3E-13	$t_{l\ m}$	0.0E+00	0.0E+00
0	2.3E-15	$n_{p\ a}$	0.0E+00	0.0E+00
0	-1.7E-15	$n_{p\ m}$	0.0E+00	0.0E+00
0	-9.2E-09	$k_{0\ Au}(a)$	0.0E+00	0.0E+00
0	1.8E-10	$k_{0\ Au}(m)$	0.0E+00	0.0E+00
0	-1.3E-10	$G_{th\ a}$	0.0E+00	0.0E+00
0	-1.1E-10	$G_{e\ a}$	0.0E+00	0.0E+00
0	2.0E-10	$G_{th\ m}$	0.0E+00	0.0E+00
0	3.0E-11	$G_{e\ m}$	0.0E+00	0.0E+00
0	4.9E-12	f	0.0E+00	0.0E+00
0	2.9E-10	α	0.0E+00	0.0E+00
0	-9.3E-12	$Q_{0\ a}$	0.0E+00	0.0E+00

0	-6.8E-14	$E_{r\ a}$	0.0E+00	0.0E+00
0	1.5E-11	$Q_{0\ m}$	0.0E+00	0.0E+00
0	6.4E-15	$E_{r\ m}$	0.0E+00	0.0E+00
0	6.8E-10	$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$	0.0E+00	0.0E+00
0	2.7E-10	COI_m / COI_a	0.0E+00	0.0E+00
0	2.7E-08	m_m	0.0E+00	0.0E+00
0	-9.7E-10	m_a	0.0E+00	0.0E+00
0	5.0E-08	w_m	0.0E+00	0.0E+00
1	-2.3E-12	υ	0.0E+00	0.0E+00
		$\mathbf{c}_i$	3.4E-17	-1.1E-11

$P_{\gamma 6\ a}$	$P/T_{\gamma 6\ a}$	$a_{\gamma 9\ a}$	$c_{\gamma 9\ a}$	$P_{\gamma 9\ a}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	1.8E-03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.3E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	6.2E-03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-06
2.4E-01	-7.4E-03	5.1E-03	9.1E-03	-1.3E-02

$t_{1/2\ a}$	$t_{1/2\ m}$	$t_{d\ a}$	$t_{c\ a}$	$t_{l\ a}$	$t_{d\ m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
3.0E+04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	6.7E+08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.2E+03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E+03
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.0E-17	-1.4E-18	6.9E-17	4.0E-17	-1.9E-16	-9.7E-19

$t_{c\ m}$	$t_{l\ m}$	$n_{p\ a}$	$n_{p\ m}$	$k_{0\ Au}(a)$	$k_{0\ Au}(m)$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	6.0E+06	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.9E+05	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.6E-08	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.8E-05
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.2E-14	3.3E-13	2.3E-15	-1.7E-15	-9.2E-09	1.8E-10

$G_{th\ a}$	$G_{e\ a}$	$G_{th\ m}$	$G_{e\ m}$	f
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E-01
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.3E-10	-1.1E-10	2.0E-10	3.0E-11	4.9E-12

α	$Q_{0\,a}$	$E_{r\,a}$	$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	4.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	1.7E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	2.4E-01	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	3.6E-03	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.8E+01	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.2E-05
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.9E-10	-9.3E-12	-6.8E-14	1.5E-11	6.4E-15	6.8E-10

COI_m / COI_a	m_m	m_a	w_m	υ
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.7E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	2.5E-09	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.5E-09	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	2.1E-09	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.4E+00
2.7E-10	2.7E-08	-9.7E-10	5.0E-08	-2.3E-12

Irradiation and γ-spectrometry

end irradiation		9/12/2017	2.46 PM
irradiation time / s		21600	

library	CSF.Lib
calib	OR50_source2016_geom_cont_12052017.Clb
sm type	CSF.Lib (ROI32 Analysis)

Nuclide	Channel	Energy	Background
51Cr	1279.1	320.1	1066118
Co60	4691.96	1173.2	5220

	target	product
analite, a	^{50}Cr	^{51}Cr
monitor, m	^{59}Co	^{60}Co

Uncertainty budget of ρ_a

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
t_i		s	21600
μ		1	0.0445
$t_{1/2\ a}$		s	2393280
	λ_a	s^{-1}	2.89622E-07
$t_{1/2\ m}$		s	166345920
	λ_m	s^{-1}	4.16690E-09
$t_{d\ a}$		s	2.404405E+06
$t_{c\ a}$		s	1.29262800E+06
$t_{l\ a}$		s	1.26426800E+06
$t_{d\ m}$		s	3.722775E+06
$t_{c\ m}$		s	7.9700E+02
$t_{l\ m}$		s	7.4000E+02
	δ_a	1	1.022
	δ_m	1	1.077
	ξ_a	1	1.00098
	ξ_m	1	1.00319
$n_{p\ a}$		1	5.26E+04
$n_{p\ m}$		1	1.3749E+05
$k_{0\ Au}(a)$		1	2.620E-03
$k_{0\ Au}(m)$		1	1.3200
$G_{th\ a}$		1	1

$G_{e\ a}$		1		1
$G_{th\ m}$		1		1
$G_{e\ m}$		1		1
f		1		15.60
α		1		-0.0360
$Q_{0\ a}$		1		0.53
$E_{r\ a}$		eV		7530
	$Q_{0\ a}(\alpha)$	1		0.59
$Q_{0\ m}$		1		1.993
$E_{r\ m}$		eV		136.0
	$Q_{0\ m}(\alpha)$	1		2.319
$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$		1		0.3507
COI_m / COI_a		1		0.857
m_m		g		0.00847
m_a		g		0.24000
w_m		g g^{-1}		0.004597
υ		mg L^{-1}		99.2
Y		[Y]	y	
ρ_a		g mL^{-1}		2.096E-09

Uncertainty budget of $\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$

Input Quantity X_i	Quantity X_i	Unit $[X_i]$	Value x_i	
a_1		Mev-1		-0.472
a_0			1	-3.229
a_{-1}		Mev		0.403
a_{-2}		Mev2		-0.0320
a_{-3}		Mev3		0.000573
$E_{\gamma\ m}$		MeV		1.17320
$E_{\gamma\ a}$		MeV		0.32010
Δd_a		mm		0.00
Δd_m		mm		0.00
	e_4	keV-4		-7.10E-11
	e_3	keV-3		5.19E-08
	e_2	keV-2		-1.43E-05
	e_1	keV-1		1.78E-03
	e_0		1	-4.46E-02
	d_1	keV-1		5.56E-06

	d_0		1	4.17E-02
$\delta\varepsilon_{r\,a}$		mm^{-1}		0.043
$\delta\varepsilon_{r\,m}$		mm^{-1}		0.048
Y		[Y]	y	
$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$		1		0.3507

Uncertainty budget of COI_m / COI_a

Input Quantity	Quantity X_i	Unit $[X_i]$	Value x_i	
a_1		Mev-1		-0.472
a_0			1	-3.229
a_{-1}		Mev		0.403
a_{-2}		Mev2		-0.0320
a_{-3}		Mev3		0.000573
	b_1		1	-0.571
	b_0		1	1.079
	c_2		1	-1.625
	c_1		1	6.678
	c_0		1	-7.006
$E_{\gamma 2\,m}$		keV		1332.50
$a_{\gamma 2\,m}$			1	1.000
$c_{\gamma 2\,m}$			1	1.000
$P/T_{\gamma 2\,m}$			1	0.197
	Y	[Y]	y	
	COI_m / COI_a		1	0.857

Net area	Cnts/s	Uncert %	FWHM	source file	start counting
52632	0.042	2.81	1.277	OR50_20171025_CSF_sa	10/10/2017
137487	185.919	0.32	1.798	OR50_20170925_Co_sa	10/25/2017

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
17	0.1%	3.0E-16	2.7E-29	0.0%	2.2E+04	2.1E-09
0.0005	1.1%	-1.0E-10	2.7E-27	0.0%	4.5E-02	2.1E-09
207	0.0%	1.1E-16	5.2E-28	0.0%	2.4E+06	2.1E-09
2.5E-11	0.0%					
25920	0.0%	-1.2E-17	1.0E-25	0.0%	1.7E+08	2.1E-09
6.5E-13	0.0%					
3.5E+01	0.0%	6.1E-16	4.4E-28	0.0%	2.4E+06	2.1E-09
2.9E-01	0.0%	3.6E-16	1.1E-32	0.0%	1.3E+06	2.1E-09
2.9E-01	0.0%	-1.7E-15	2.5E-31	0.0%	1.3E+06	2.1E-09
3.5.E+01	0.0%	-8.7E-18	9.2E-32	0.0%	3.7E+06	2.1E-09
2.9E-01	0.0%	-1.1E-13	9.8E-28	0.0%	8.0E+02	2.1E-09
2.9E-01	0.0%	2.9E-12	7.2E-25	0.0%	7.4E+02	2.1E-09
0.000	0.0%					
0.001	0.1%					
0.00001	0.0%					
0.00004	0.0%					
1.5E+03	2.8%	4.0E-14	3.5E-21	35.3%	5.4E+04	2.2E-09
4.4E+02	0.3%	-1.5E-14	4.5E-23	0.5%	1.4E+05	2.1E-09
1.3E-05	0.5%	-8.0E-07	1.1E-22	1.1%	2.6E-03	2.1E-09
0.0053	0.4%	1.6E-09	7.0E-23	0.7%	1.3E+00	2.1E-09
0	0.0%	-2.0E-09	0.0E+00	0.0%	1.0E+00	2.1E-09

0	0.0%	-7.7E-11	0.0E+00	0.0%	1.0E+00	2.1E-09
0	0.0%	1.8E-09	0.0E+00	0.0%	1.0E+00	2.1E-09
0	0.0%	2.7E-10	0.0E+00	0.0%	1.0E+00	2.1E-09
0.33	2.1%	-1.2E-11	1.7E-23	0.2%	1.6E+01	2.1E-09
0.0064	17.8%	-9.0E-10	3.3E-23	0.3%	-3.0E-02	2.1E-09
0.11	20.0%	-1.8E-10	3.6E-22	3.6%	6.4E-01	2.1E-09
828	11.0%	-8.7E-17	5.1E-27	0.0%	8.4E+03	2.1E-09
0.15	24.8%					
0.060	3.0%	1.4E-10	7.0E-23	0.7%	2.1E+00	2.1E-09
6.9	5.1%	5.8E-14	1.6E-25	0.0%	1.4E+02	2.1E-09
0.095	4.1%					
0.0087	2.5%	6.0E-09	2.7E-21	27.4%	3.6E-01	2.1E-09
0.017	2.0%	2.4E-09	1.7E-21	17.6%	8.7E-01	2.1E-09
0.00005	0.6%	2.5E-07	1.5E-22	1.6%	8.5E-03	2.1E-09
0.00005	0.0%	-8.7E-09	1.9E-25	0.0%	2.4E-01	2.1E-09
0.000046	1.0%	4.6E-07	4.4E-22	4.5%	4.6E-03	2.1E-09
1.2	1.2%	-2.1E-11	6.4E-22	6.5%	1.0E+02	2.1E-09
$u_c(y)$	$u_{c\,r}(y)$			Σ		
9.9E-11	4.7%			100.0%		

Std unc $u(x_i)$	Rel std unc $u_r(x_i)$	**Sensit coeff** c_i	Variance y $u^2_y(x_i)$	**Index**	Input for sensit coeff $x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	3.0E-01	5.6E-05	74.1%	-4.3E-01	3.6E-01
0.057	1.8%	0.0E+00	0.0E+00	0.0%	-3.2E+00	3.5E-01
0.020	4.8%	-8.0E-01	-3.3E-05	-43.1%	4.2E-01	3.4E-01
0.0022	6.9%	-3.2E+00	9.8E-06	12.9%	-3.0E-02	3.4E-01
0.000075	13.1%	-1.0E+01	-8.1E-07	-1.1%	6.5E-04	3.5E-01
0.00012	0.0%	-2.5E-01	8.7E-10	0.0%	1.2E+00	3.5E-01
0.00012	0.0%	9.2E-01	1.1E-08	0.0%	3.2E-01	3.5E-01
0.29		1.5E-02	1.9E-05	25.6%	2.9E-01	3.6E-01
0.29		-1.7E-02	2.4E-05	31.5%	2.9E-01	3.5E-01
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					

0.0000	0.0%					
0.005	11.5%	0.0E+00	0.0E+00	0.0%	4.8E-02	3.5E-01
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.4E-02	3.5E-01
$u_c(y)$	$u_{c\,r}(y)$			Σ		
0.0087	2.5%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	-1.9E-01	1.7E-05	5.9%	-4.3E-01	8.5E-01
0.057	1.8%	-1.4E-01	-1.4E-05	-4.9%	-3.2E+00	8.5E-01
0.020	4.8%	-1.1E-01	3.0E-06	1.0%	4.2E-01	8.6E-01
0.0022	6.9%	-8.0E-02	-2.2E-07	-0.1%	-3.0E-02	8.6E-01
0.000075	13.1%	-6.0E-02	5.0E-09	0.0%	6.5E-04	8.6E-01
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0.12	0.0%	9.6E-05	1.2E-10	0.0%	1.3E+03	8.6E-01
0.012	1.2%	-1.4E-01	2.7E-06	0.9%	1.0E+00	8.6E-01
0.012	1.2%	-1.4E-01	2.7E-06	0.9%	1.0E+00	8.6E-01
0.023	11.5%	7.3E-01	2.8E-04	96.2%	2.2E-01	8.7E-01
$u_c(y)$	$u_r(y)$			Σ		
0.017	2.0%			100.0%		

	t_c / s	t_l / s	$t_{dead\ r}$ / %	t_d / s	t_c / $t_{1/2}$	t_d / $t_{1/2}$
10:39 AM	1292628	1264268	2.2%	2404405	0.54	1.0
4:52 PM	797	740	7.2%	3722775	0.00	0.0

Correlation matrix of ρ_a

x_i-u(x_i)	y(x_i-u(x_i))		t_i	μ	$t_{1/2\ a}$	$t_{1/2\ m}$
2.2E+04	2.1E-09	t_i	1	0	0	0
4.4E-02	2.1E-09	μ	0	1	0	0
2.4E+06	2.1E-09	$t_{1/2\ a}$	0	0	1	0
		$t_{1/2\ m}$	0	0	0	1
1.7E+08	2.1E-09	$t_{d\ a}$	0	0	0	0
		$t_{c\ a}$	0	0	0	0
2.4E+06	2.1E-09	$t_{l\ a}$	0	0	0	0
1.3E+06	2.1E-09	$t_{d\ m}$	0	0	0	0
1.3E+06	2.1E-09	$t_{c\ m}$	0	0	0	0
3.7E+06	2.1E-09	$t_{l\ m}$	0	0	0	0
8.0E+02	2.1E-09	$n_{p\ a}$	0	0	0	0
7.4E+02	2.1E-09	$n_{p\ m}$	0	0	0	0
		$k_{0\ Au}$(a)	0	0	0	0
		$k_{0\ Au}$(m)	0	0	0	0
		$G_{th\ a}$	0	0	0	0
		$G_{e\ a}$	0	0	0	0
5.1E+04	2.0E-09	$G_{th\ m}$	0	0	0	0
1.4E+05	2.1E-09	$G_{e\ m}$	0	0	0	0
2.6E-03	2.1E-09	f	0	0	0	0
1.3E+00	2.1E-09	α	0	0	0	0
1.0E+00	2.1E-09	$Q_{0\ a}$	0	0	0	0

1.0E+00	2.1E-09
1.0E+00	2.1E-09
1.0E+00	2.1E-09
1.5E+01	2.1E-09
-4.2E-02	2.1E-09
4.2E-01	2.1E-09
6.7E+03	2.1E-09
1.9E+00	2.1E-09
1.3E+02	2.1E-09
3.4E-01	2.0E-09
8.4E-01	2.1E-09
8.4E-03	2.1E-09
2.4E-01	2.1E-09
4.6E-03	2.1E-09
9.8E+01	2.1E-09

$E_{r\ a}$	0	0	0	0
$Q_{0\ m}$	0	0	0	0
$E_{r\ m}$	0	0	0	0
$\varepsilon_{p\ m}^{geo}$ / $\varepsilon_{p\ a}$	0	0	0	0
COI_m / COI_a	0	0	0	0
m_m	0	0	0	0
m_a	0	0	0	0
w_m	0	0	0	0
υ	0	0	0	0

Correlation matrix of $\varepsilon_{p\ m}^{geo}$ / $\varepsilon_{p\ a}^{geo}$

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	3.4E-01
-3.3E+00	3.5E-01
3.8E-01	3.7E-01
-3.4E-02	3.6E-01
5.0E-04	3.5E-01
1.2E+00	3.5E-01
3.2E-01	3.5E-01
-2.9E-01	3.5E-01
-2.9E-01	3.6E-01

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma\ m}$	0	0	0	0
$E_{\gamma\ a}$	0	0	0	0
Δd_a	0	0	0	0
Δd_m	0	0	0	0
$\delta\varepsilon_{r\ a}$	0	0	0	0
$\delta\varepsilon_{r\ m}$	0	0	0	0

3.8E-02	3.5E-01
4.3E-02	3.5E-01

Correlation matrix of COI_m / COI_a

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	8.7E-01
-3.3E+00	8.7E-01
3.8E-01	8.6E-01
-3.4E-02	8.6E-01
5.0E-04	8.6E-01
1.3E+03	8.6E-01
9.9E-01	8.6E-01
9.9E-01	8.6E-01
1.7E-01	8.4E-01

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma 2\ m}$	0	0	0	0
$a_{\gamma 2\ m}$	0	0	0	0
$c_{\gamma 2\ m}$	0	0	0	0
$P/T_{\gamma 2\ m}$	0	0	0	0

$t_{d\,a}$	$t_{c\,a}$	$t_{l\,a}$	$t_{d\,m}$	$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

a_{-3}	$E_{\gamma m}$	$E_{\gamma a}$	Δd_a	Δd_m	$\delta\varepsilon_{r a}$	$\delta\varepsilon_{r m}$	c_i
0.748	0	0	0	0	0	0	3.0E-01
-0.848	0	0	0	0	0	0	0.0E+00
0.957	0	0	0	0	0	0	-8.0E-01
-0.993	0	0	0	0	0	0	-3.2E+00
1.000	0	0	0	0	0	0	-1.0E+01
0	1	0	0	0	0	0	-2.5E-01
0	0	1	0	0	0	0	9.2E-01
0	0	0	1	0	0	0	1.5E-02
0	0	0	0	1	0	0	-1.7E-02
0	0	0	0	0	1	1	0.0E+00
0	0	0	0	0	1	1	0.0E+00

Covariance

a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	c_i	
0.748	0	0	0	0	-1.9E-01	a_1
-0.848	0	0	0	0	-1.4E-01	a_0
0.957	0	0	0	0	-1.1E-01	a_{-1}
-0.993	0	0	0	0	-8.0E-02	a_{-2}
1.000	0	0	0	0	-6.0E-02	a_{-3}
0	1	0	0	0	9.6E-05	$E_{\gamma 2\ m}$
0	0	1	0	0	-1.4E-01	$a_{\gamma 2\ m}$
0	0	0	1	0	-1.4E-01	$c_{\gamma 2\ m}$
0	0	0	0	1	7.3E-01	$P/T_{\gamma 2\ m}$

c_i

$k_{0\,Au}(m)$	$G_{th\,a}$	$G_{e\,a}$	$G_{th\,m}$	$G_{e\,m}$	f	α	$Q_{0\,a}$	$E_{r\,a}$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0

0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Covariance matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

	a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma\,m}$	$E_{\gamma\,a}$
a_1	1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00
a_0	-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00
a_{-1}	7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00
a_{-3}	2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00
$E_{\gamma\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08	0.0E+00
$E_{\gamma\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08
Δd_a	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Δd_m	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
c_i	3.0E-01	0.0E+00	-8.0E-01	-3.2E+00	-1.0E+01	-2.5E-01	9.2E-01

matrix of COI_m/COI_a

a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$
1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-04
-1.9E-01	-1.4E-01	-1.1E-01	-8.0E-02	-6.0E-02	9.6E-05	-1.4E-01	-1.4E-01	7.3E-01

$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}{}^{geo} / \varepsilon_{p\,a}{}^{geo}$	COI_m / COI_a	m_m	m_a	w_m
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

0	0	0	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	1	0	0	0	0
0	0	0	1	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	1	0
0	0	0	0	0	0	1
0	0	0	0	0	0	0

Δd_a	Δd_m	$\delta\varepsilon_{r\,a}$	$\delta\varepsilon_{r\,m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.5E-05	2.8E-05
0.0E+00	0.0E+00	2.8E-05	3.1E-05
1.5E-02	-1.7E-02	0.0E+00	0.0E+00

Covariance matrix of ρ_a

υ	c_i		t_i	μ
0	3.0E-16	t_i	3.0E+02	0.0E+00
0	-1.0E-10	μ	0.0E+00	2.5E-07
0	1.1E-16	$t_{1/2\ a}$	0.0E+00	0.0E+00
0	-1.2E-17	$t_{1/2\ m}$	0.0E+00	0.0E+00
0	6.1E-16	$t_{d\ a}$	0.0E+00	0.0E+00
0	3.6E-16	$t_{c\ a}$	0.0E+00	0.0E+00
0	-1.7E-15	$t_{l\ a}$	0.0E+00	0.0E+00
0	-8.7E-18	$t_{d\ m}$	0.0E+00	0.0E+00
0	-1.1E-13	$t_{c\ m}$	0.0E+00	0.0E+00
0	2.9E-12	$t_{l\ m}$	0.0E+00	0.0E+00
0	4.0E-14	$n_{p\ a}$	0.0E+00	0.0E+00
0	-1.5E-14	$n_{p\ m}$	0.0E+00	0.0E+00
0	-8.0E-07	$k_{0\ Au}(a)$	0.0E+00	0.0E+00
0	1.6E-09	$k_{0\ Au}(m)$	0.0E+00	0.0E+00
0	-2.0E-09	$G_{th\ a}$	0.0E+00	0.0E+00
0	-7.7E-11	$G_{e\ a}$	0.0E+00	0.0E+00
0	1.8E-09	$G_{th\ m}$	0.0E+00	0.0E+00
0	2.7E-10	$G_{e\ m}$	0.0E+00	0.0E+00
0	-1.2E-11	f	0.0E+00	0.0E+00
0	-9.0E-10	α	0.0E+00	0.0E+00
0	-1.8E-10	$Q_{0\ a}$	0.0E+00	0.0E+00

0	-8.7E-17	$E_{r\ a}$	0.0E+00	0.0E+00
0	1.4E-10	$Q_{0\ m}$	0.0E+00	0.0E+00
0	5.8E-14	$E_{r\ m}$	0.0E+00	0.0E+00
0	6.0E-09	$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$	0.0E+00	0.0E+00
0	2.4E-09	COI_m / COI_a	0.0E+00	0.0E+00
0	2.5E-07	m_m	0.0E+00	0.0E+00
0	-8.7E-09	m_a	0.0E+00	0.0E+00
0	4.6E-07	w_m	0.0E+00	0.0E+00
1	-2.1E-11	υ	0.0E+00	0.0E+00
		$\mathbf{c}_i$	3.0E-16	-1.0E-10

$t_{1/2\ a}$	$t_{1/2\ m}$	$t_{d\ a}$	$t_{c\ a}$	$t_{l\ a}$	$t_{d\ m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.3E+04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	6.7E+08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.2E+03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E+03
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.1E-16	-1.2E-17	6.1E-16	3.6E-16	-1.7E-15	-8.7E-18

$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$	$k_{0\,Au}(m)$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.2E+06	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.9E+05	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.7E-10	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.8E-05
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.1E-13	2.9E-12	4.0E-14	-1.5E-14	-8.0E-07	1.6E-09

$G_{th\ a}$	$G_{e\ a}$	$G_{th\ m}$	$G_{e\ m}$	f
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E-01
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.0E-09	-7.7E-11	1.8E-09	2.7E-10	-1.2E-11

α	$Q_{0\,a}$	$E_{r\,a}$	$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	4.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	1.1E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	6.9E+05	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	3.6E-03	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.8E+01	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.6E-05
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-9.0E-10	-1.8E-10	-8.7E-17	1.4E-10	5.8E-14	6.0E-09

COI_m / COI_a	m_m	m_a	w_m	υ
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.9E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	2.5E-09	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.5E-09	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	2.1E-09	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.4E+00
2.4E-09	2.5E-07	-8.7E-09	4.6E-07	-2.1E-11

Irradiation and γ-spectrometry

end irradiation		9/12/2017	2.46 PM
irradiation time / s		21600	

library	CSF.Lib
calib	OR50_source2016_geom_cont_12052017.Clb
sm type	CSF.Lib (ROI32 Analysis)

Nuclide	Channel	Energy	Background
131Ba	1983.94	496.3	414907
Co60	4691.96	1173.2	5220

	target	product
analite, a	^{130}Ba	^{131}Ba
monitor, m	^{59}Co	^{60}Co

Uncertainty budget of ρ_a

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
t_i		s	21600
μ		1	0.0445
$t_{1/2\ a}$		s	993600
	λ_a	s^{-1}	7.0E-07
$t_{1/2\ m}$		s	1.7E+08
	λ_m	s^{-1}	4.2E-09
$t_{d\ a}$		s	2404405
$t_{c\ a}$		s	1292628
$t_{l\ a}$		s	1264268
$t_{d\ m}$		s	3722775
$t_{c\ m}$		s	797
$t_{l\ m}$		s	740
	δ_a	1	1.022
	δ_m	1	1.077
	ξ_a	1	1.00098
	ξ_m	1	1.00319
$n_{p\ a}$		1	50777
$n_{p\ m}$		1	137487
$k_{0\ Au}(a)$		1	0.00006480
$k_{0\ Au}(m)$		1	1.3200
$G_{th\ a}$		1	1

$G_{e\,a}$		1	1
$G_{th\,m}$		1	1
$G_{e\,m}$		1	1
f		1	15.60
α		1	-0.0360
$Q_{0\,a}$		1	24.8
$E_{r\,a}$		eV	69.9
	$Q_{0\,a}(\alpha)$	1	28.85
$Q_{0\,m}$		1	1.993
$E_{r\,m}$		eV	136.0
	$Q_{0\,m}(\alpha)$	1	2.319
$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$		1	0.5033
COI_m / COI_a		1	0.981
m_m		g	0.00847
m_a		g	0.24000
w_m		$g\,g^{-1}$	0.004597
υ		$mg\,L^{-1}$	99.2
Y		[Y]	y
ρ_a		$g\,mL^{-1}$	6.89E-08

Uncertainty budget of $\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$

Input Quantity	Quantity	Unit	Value
X_i	**X_i**	**$[X_i]$**	**x_i**
a_1		Mev-1	-0.472
a_0		1	-3.229
a_{-1}		Mev	0.403
a_{-2}		Mev2	-0.0320
a_{-3}		Mev3	0.000573
$E_{\gamma\,m}$		MeV	1.17320
$E_{\gamma\,a}$		MeV	0.49630
Δd_a		mm	0
Δd_m		mm	0
	e_4	keV-4	-7.1E-11
	e_3	keV-3	5.2E-08
	e_2	keV-2	-1.4E-05
	e_1	keV-1	1.8E-03
	e_0	1	-4.5E-02
	d_1	keV-1	5.6E-06

	d_0		1	4.2E-02
$\delta\varepsilon_{r\,a}$		mm^{-1}		0.044
$\delta\varepsilon_{r\,m}$		mm^{-1}		0.048
Y		[Y]	y	
$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$		1		0.503

Uncertainty budget of COI_m / COI_a

Input Quantity	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i	
a_1		Mev-1		-0.472
a_0			1	-3.229
a_{-1}		Mev		0.403
a_{-2}		Mev2		-0.0320
a_{-3}		Mev3		0.000573
	b_1		1	-0.571
	b_0		1	1.079
	c_2		1	-1.625
	c_1		1	6.678
	c_0		1	-7.006
$E_{\gamma 2\,m}$		keV		1332.5
$a_{\gamma 2\,m}$			1	1.000
$c_{\gamma 2\,m}$			1	1.000
$P/T_{\gamma 2\,m}$			1	0.197
$E_{\gamma 29\,a}$		keV		123.80
$a_{\gamma 29\,a}$			1	1.000
$c_{\gamma 29\,a}$			1	0.550
$P/T_{\gamma 29\,a}$			1	0.712
	Y	[Y]	y	
	COI_m / COI_a		1	0.981

Net area	Cnts/s	Uncert %	FWHM	source file	start counting
50777	0.04	2.37	1.368	OR50_20171025_CSF_s	10/10/2017
137487	185.919	0.32	1.798	OR50_20170925_Co_sa	10/25/2017

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
17	0.1%	2.4E-14	1.7E-25	0.0%	2.2E+04	6.9E-08
0.0005	1.1%	-3.4E-09	2.9E-24	0.0%	4.5E-02	6.9E-08
5184	0.5%	-7.4E-14	1.5E-19	0.2%	1.0E+06	6.8E-08
3.6E-09	0.5%					
2.6E+04	0.0%	-4.1E-16	1.1E-22	0.0%	1.7E+08	6.9E-08
6.5E-13	0.0%					
35	0.0%	4.8E-14	2.8E-24	0.0%	2.4E+06	6.9E-08
0.3	0.0%	2.3E-14	4.3E-29	0.0%	1.3E+06	6.9E-08
0.3	0.0%	-5.7E-14	2.7E-28	0.0%	1.3E+06	6.9E-08
35	0.0%	-2.9E-16	9.9E-29	0.0%	3.7E+06	6.9E-08
0.3	0.0%	-3.6E-12	1.1E-24	0.0%	8.0E+02	6.9E-08
0.3	0.0%	9.7E-11	7.8E-22	0.0%	7.4E+02	6.9E-08
0.000	0.0%					
0.001	0.1%					
0.00001	0.0%					
0.00004	0.0%					
1203	2.4%	1.4E-12	2.7E-18	2.9%	5.2E+04	7.1E-08
440	0.3%	-5.0E-13	4.9E-20	0.1%	1.4E+05	6.9E-08
0.00000013	0.2%	-1.1E-03	1.9E-20	0.0%	6.5E-05	6.9E-08
0.0053	0.4%	5.2E-08	7.6E-20	0.1%	1.3E+00	6.9E-08
0	0.0%	-2.4E-08	0.0E+00	0.0%	1.0E+00	6.9E-08

0	0.0%	-4.5E-08	0.0E+00	0.0%	1.0E+00	6.9E-08
0	0.0%	6.0E-08	0.0E+00	0.0%	1.0E+00	6.9E-08
0	0.0%	8.9E-09	0.0E+00	0.0%	1.0E+00	6.9E-08
0.33	2.1%	2.3E-09	5.6E-19	0.6%	1.6E+01	7.0E-08
0.0064	17.8%	1.5E-07	9.2E-19	1.0%	-3.0E-02	7.0E-08
5.0	20.0%	-1.8E-09	8.3E-17	89.3%	3.0E+01	6.1E-08
3.5	5.0%	-2.3E-11	6.3E-21	0.0%	7.3E+01	6.9E-08
5.83	20.2%					
0.060	3.0%	4.6E-09	7.5E-20	0.1%	2.1E+00	6.9E-08
6.9	5.1%	1.9E-12	1.7E-22	0.0%	1.4E+02	6.9E-08
0.095	4.1%					
0.0126	2.5%	1.4E-07	3.0E-18	3.2%	5.2E-01	7.1E-08
0.015	1.6%	7.0E-08	1.2E-18	1.3%	1.0E+00	7.0E-08
0.00005	0.6%	8.1E-06	1.7E-19	0.2%	8.5E-03	6.9E-08
0.00005	0.0%	-2.9E-07	2.1E-22	0.0%	2.4E-01	6.9E-08
0.000046	1.0%	1.5E-05	4.7E-19	0.5%	4.6E-03	7.0E-08
1.2	1.2%	-6.9E-10	6.9E-19	0.7%	1.0E+02	6.8E-08
$u_c(y)$	$u_{c\,r}(y)$			Σ		
9.6E-09	14.0%			100.0%		

Std unc **$u(x_i)$**	Rel std unc $u_r(x_i)$	**Sensit coeff** **c_i**	Variance y $u^2_y(x_i)$	**Index**	Input for sensit coeff $x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	3.4E-01	1.1E-04	70.0%	-4.3E-01	5.2E-01
0.057	1.8%	0.0E+00	0.0E+00	0.0%	-3.2E+00	5.0E-01
0.020	4.8%	-5.9E-01	-5.8E-05	-36.5%	4.2E-01	4.9E-01
0.0022	6.9%	-1.7E+00	1.5E-05	9.7%	-3.0E-02	5.0E-01
0.000075	13.1%	-3.8E+00	-1.0E-06	-0.6%	6.5E-04	5.0E-01
0.00012	0.0%	-3.7E-01	1.8E-09	0.0%	1.2E+00	5.0E-01
0.00012	0.0%	8.1E-01	8.8E-09	0.0%	5.0E-01	5.0E-01
0.29		2.2E-02	4.2E-05	26.4%	2.9E-01	5.1E-01
0.29		-2.4E-02	4.9E-05	31.0%	2.9E-01	5.0E-01
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					

0.0000	0.0%					
0.005	11.5%	0.0E+00	0.0E+00	0.0%	5.0E-02	5.0E-01
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.4E-02	5.0E-01
$u_c(y)$	$u_{c\ r}(y)$			Σ		
0.013	2.5%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	-0.2000	1.7E-05	7.1%	-4.3E-01	9.7E-01
0.057	1.8%	-0.0216	-1.9E-06	-0.8%	-3.2E+00	9.8E-01
0.020	4.8%	1.0307	-2.3E-05	-9.6%	4.2E-01	1.0E+00
0.0022	6.9%	9.2132	2.0E-05	8.3%	-3.0E-02	1.0E+00
0.000075	13.1%	74.6117	-5.0E-06	-2.1%	6.5E-04	9.9E-01
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0.1	0.0%	0.0001	1.6E-10	0.0%	1.3E+03	9.8E-01
0.012	1.2%	-0.1632	3.6E-06	1.5%	1.0E+00	9.8E-01
0.012	1.2%	-0.1632	3.6E-06	1.5%	1.0E+00	9.8E-01
0.023	11.5%	0.8402	2.8E-04	116.9%	2.2E-01	1.0E+00
0.12	0.1%	-0.0001	4.8E-11	0.0%	1.2E+02	9.8E-01
0.012	1.2%	0.1416	2.7E-06	1.1%	1.0E+00	9.8E-01
0.012	2.1%	0.2575	8.8E-06	3.7%	5.6E-01	9.8E-01
0.023	3.2%	-0.1991	-6.6E-05	-27.7%	7.4E-01	9.8E-01
$u_c(y)$	$u_r(y)$			Σ		
0.015	1.6%			100.0%		

	t_c / s	t_l / s	$t_{dead\ r}$ / %	t_d / s	t_c / $t_{1/2}$	t_d / $t_{1/2}$
10:39 AM	1292628	1264268	2.2%	2404405	1.30	2.4
4:52 PM	797	740	7.2%	3722775	0.00	0.0

Correlation matrix of ρ_a

x_i-u(x_i)	y(x_i-u(x_i))		t_i	μ	$t_{1/2\ a}$	$t_{1/2\ m}$
2.2E+04	6.9E-08	t_i	1	0	0	0
4.4E-02	6.9E-08	μ	0	1	0	0
9.9E+05	6.9E-08	$t_{1/2\ a}$	0	0	1	0
		$t_{1/2\ m}$	0	0	0	1
1.7E+08	6.9E-08	$t_{d\ a}$	0	0	0	0
		$t_{c\ a}$	0	0	0	0
2.4E+06	6.9E-08	$t_{l\ a}$	0	0	0	0
1.3E+06	6.9E-08	$t_{d\ m}$	0	0	0	0
1.3E+06	6.9E-08	$t_{c\ m}$	0	0	0	0
3.7E+06	6.9E-08	$t_{l\ m}$	0	0	0	0
8.0E+02	6.9E-08	$n_{p\ a}$	0	0	0	0
7.4E+02	6.9E-08	$n_{p\ m}$	0	0	0	0
		$k_{0\ Au}$(a)	0	0	0	0
		$k_{0\ Au}$(m)	0	0	0	0
		$G_{th\ a}$	0	0	0	0
		$G_{e\ a}$	0	0	0	0
5.0E+04	6.7E-08	$G_{th\ m}$	0	0	0	0
1.4E+05	6.9E-08	$G_{e\ m}$	0	0	0	0
6.5E-05	6.9E-08	f	0	0	0	0
1.3E+00	6.9E-08	α	0	0	0	0
1.0E+00	6.9E-08	$Q_{0\ a}$	0	0	0	0

1.0E+00	6.9E-08	$E_{r\ a}$	0	0	0	0
1.0E+00	6.9E-08	$Q_{0\ m}$	0	0	0	0
1.0E+00	6.9E-08	$E_{r\ m}$	0	0	0	0
1.5E+01	6.8E-08	$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}$	0	0	0	0
-4.2E-02	6.8E-08	COI_m / COI_a	0	0	0	0
2.0E+01	7.9E-08	m_m	0	0	0	0
6.6E+01	6.9E-08	m_a	0	0	0	0
		w_m	0	0	0	0
1.9E+00	6.9E-08	υ	0	0	0	0
1.3E+02	6.9E-08					
4.9E-01	6.7E-08					
9.7E-01	6.8E-08					
8.4E-03	6.8E-08					
2.4E-01	6.9E-08					
4.6E-03	6.8E-08					
9.8E+01	7.0E-08					

Correlation matrix of $\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$

x_i-u(x_i)	y(x_i-u(x_i))		a_1	a_0	a_{-1}	a_{-2}
-5.2E-01	4.9E-01	a_1	1.000	-0.973	0.884	-0.804
-3.3E+00	5.0E-01	a_0	-0.973	1.000	-0.957	0.896
3.8E-01	5.1E-01	a_{-1}	0.884	-0.957	1.000	-0.984
-3.4E-02	5.1E-01	a_{-2}	-0.804	0.896	-0.984	1.000
5.0E-04	5.0E-01	a_{-3}	0.748	-0.848	0.957	-0.993
1.2E+00	5.0E-01	$E_{\gamma\ m}$	0	0	0	0
5.0E-01	5.0E-01	$E_{\gamma\ a}$	0	0	0	0
-2.9E-01	5.0E-01	Δd_a	0	0	0	0
-2.9E-01	5.1E-01	Δd_m	0	0	0	0
		$\delta\varepsilon_{r\ a}$	0	0	0	0
		$\delta\varepsilon_{r\ m}$	0	0	0	0

3.9E-02	5.0E-01
4.3E-02	5.0E-01

Correlation matrix of COI_m / COI_a

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	9.9E-01
-3.3E+00	9.8E-01
3.8E-01	9.6E-01
-3.4E-02	9.6E-01
5.0E-04	9.8E-01
1.3E+03	9.8E-01
9.9E-01	9.8E-01
9.9E-01	9.8E-01
1.7E-01	9.6E-01
1.2E+02	9.8E-01
9.9E-01	9.8E-01
5.4E-01	9.8E-01
6.9E-01	9.9E-01

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma 2\ m}$	0	0	0	0
$a_{\gamma 2\ m}$	0	0	0	0
$c_{\gamma 2\ m}$	0	0	0	0
$P/T_{\gamma 2\ m}$	0	0	0	0
$E_{\gamma 29\ a}$	0	0	0	0
$a_{\gamma 29\ a}$	0	0	0	0
$c_{\gamma 29\ a}$	0	0	0	0
$P/T_{\gamma 29\ a}$	0	0	0	0

$t_{d\,a}$	$t_{c\,a}$	$t_{l\,a}$	$t_{d\,m}$	$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

a_{-3}	$E_{\gamma m}$	$E_{\gamma a}$	Δd_a	Δd_m	$\delta\varepsilon_{r a}$	$\delta\varepsilon_{r m}$		c_i
0.748	0	0	0	0	0	0		3.4E-01
-0.848	0	0	0	0	0	0		0.0E+00
0.957	0	0	0	0	0	0		-5.9E-01
-0.993	0	0	0	0	0	0		-1.7E+00
1.000	0	0	0	0	0	0		-3.8E+00
0	1	0	0	0	0	0		-3.7E-01
0	0	1	0	0	0	0		8.1E-01
0	0	0	1	0	0	0		2.2E-02
0	0	0	0	1	0	0		-2.4E-02
0	0	0	0	0	1	1		0.0E+00
0	0	0	0	0	1	1		0.0E+00

a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	$E_{\gamma 29\ a}$	$a_{\gamma 29\ a}$	$c_{\gamma 29\ a}$	$P/T_{\gamma 29\ a}$
0.748	0	0	0	0	0	0	0	0
-0.848	0	0	0	0	0	0	0	0
0.957	0	0	0	0	0	0	0	0
-0.993	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	1
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0
0	0	0	0	1	0	0	0	1

$k_{0\,Au}(m)$	$G_{th\,a}$	$G_{e\,a}$	$G_{th\,m}$	$G_{e\,m}$	f	α	$Q_{0\,a}$	$E_{r\,a}$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0

0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Covariance matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

	a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma\,m}$	$E_{\gamma\,a}$
a_1	1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00
a_0	-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00
a_{-1}	7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00
a_{-3}	2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00
$E_{\gamma\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08	0.0E+00
$E_{\gamma\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08
Δd_a	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Δd_m	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
c_i	3.4E-01	0.0E+00	-5.9E-01	-1.7E+00	-3.8E+00	-3.7E-01	8.1E-01

Covariance matrix of COI_m/COI_a

c_i		a_1	a_0	a_{-1}
-2.0E-01	a_1	1.9E-03	-2.4E-03	7.5E-04
-2.2E-02	a_0	-2.4E-03	3.2E-03	-1.1E-03
1.0E+00	a_{-1}	7.5E-04	-1.1E-03	3.8E-04
9.2E+00	a_{-2}	-7.7E-05	1.1E-04	-4.3E-05
7.5E+01	a_{-3}	2.4E-06	-3.6E-06	1.4E-06
1.1E-04	$E_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
-1.6E-01	$a_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
-1.6E-01	$c_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
8.4E-01	$P/T_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
-6.0E-05	$E_{\gamma 29\ a}$	0.0E+00	0.0E+00	0.0E+00
1.4E-01	$a_{\gamma 29\ a}$	0.0E+00	0.0E+00	0.0E+00
2.6E-01	$c_{\gamma 29\ a}$	0.0E+00	0.0E+00	0.0E+00
-2.0E-01	$P/T_{\gamma 29\ a}$	0.0E+00	0.0E+00	0.0E+00
	c_i	-2.0E-01	-2.2E-02	1.0E+00

$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	COI_m / COI_a	m_m	m_a	w_m
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

0	0	0	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	1	0	0	0	0
0	0	0	1	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	1	0
0	0	0	0	0	0	1
0	0	0	0	0	0	0

Δd_a	Δd_m	$\delta\varepsilon_{r\,a}$	$\delta\varepsilon_{r\,m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.6E-05	2.9E-05
0.0E+00	0.0E+00	2.9E-05	3.1E-05
2.2E-02	-2.4E-02	0.0E+00	0.0E+00

a_{-2}	a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	$E_{\gamma 29\ a}$
-7.7E-05	2.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.1E-04	-3.6E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-4.3E-05	1.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.9E-06	-1.7E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.7E-07	5.7E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-02
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-04	0.0E+00
9.2E+00	7.5E+01	1.1E-04	-1.6E-01	-1.6E-01	8.4E-01	-6.0E-05

Covariance matrix of ρ_a

υ	c_i		t_i	μ
0	2.4E-14	t_i	3.0E+02	0.0E+00
0	-3.4E-09	μ	0.0E+00	2.5E-07
0	-7.4E-14	$t_{1/2\ a}$	0.0E+00	0.0E+00
0	-4.1E-16	$t_{1/2\ m}$	0.0E+00	0.0E+00
0	4.8E-14	$t_{d\ a}$	0.0E+00	0.0E+00
0	2.3E-14	$t_{c\ a}$	0.0E+00	0.0E+00
0	-5.7E-14	$t_{l\ a}$	0.0E+00	0.0E+00
0	-2.9E-16	$t_{d\ m}$	0.0E+00	0.0E+00
0	-3.6E-12	$t_{c\ m}$	0.0E+00	0.0E+00
0	9.7E-11	$t_{l\ m}$	0.0E+00	0.0E+00
0	1.4E-12	$n_{p\ a}$	0.0E+00	0.0E+00
0	-5.0E-13	$n_{p\ m}$	0.0E+00	0.0E+00
0	-1.1E-03	$k_{0\ Au}(a)$	0.0E+00	0.0E+00
0	5.2E-08	$k_{0\ Au}(m)$	0.0E+00	0.0E+00
0	-2.4E-08	$G_{th\ a}$	0.0E+00	0.0E+00
0	-4.5E-08	$G_{e\ a}$	0.0E+00	0.0E+00
0	6.0E-08	$G_{th\ m}$	0.0E+00	0.0E+00
0	8.9E-09	$G_{e\ m}$	0.0E+00	0.0E+00
0	2.3E-09	f	0.0E+00	0.0E+00
0	1.5E-07	α	0.0E+00	0.0E+00
0	-1.8E-09	$Q_{0\ a}$	0.0E+00	0.0E+00

0	-2.3E-11	$E_{r\,a}$	0.0E+00	0.0E+00
0	4.6E-09	$Q_{0\,m}$	0.0E+00	0.0E+00
0	1.9E-12	$E_{r\,m}$	0.0E+00	0.0E+00
0	1.4E-07	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	0.0E+00	0.0E+00
0	7.0E-08	COI_m / COI_a	0.0E+00	0.0E+00
0	8.1E-06	m_m	0.0E+00	0.0E+00
0	-2.9E-07	m_a	0.0E+00	0.0E+00
0	1.5E-05	w_m	0.0E+00	0.0E+00
1	-6.9E-10	υ	0.0E+00	0.0E+00
		$\mathbf{c}_i$	2.4E-14	-3.4E-09

$a_{\gamma 29\ a}$	$c_{\gamma 29\ a}$	$P/T_{\gamma 29\ a}$
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	5.2E-04
0.0E+00	0.0E+00	0.0E+00
1.3E-04	0.0E+00	0.0E+00
0.0E+00	1.3E-04	0.0E+00
0.0E+00	0.0E+00	5.2E-04
1.4E-01	2.6E-01	-2.0E-01

$t_{1/2\ a}$	$t_{1/2\ m}$	$t_{d\ a}$	$t_{c\ a}$	$t_{l\ a}$	$t_{d\ m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.7E+07	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	6.7E+08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.2E+03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E+03
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-7.4E-14	-4.1E-16	4.8E-14	2.3E-14	-5.7E-14	-2.9E-16

$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$	$k_{0\,Au}(m)$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.4E+06	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.9E+05	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.7E-14	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.8E-05
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-3.6E-12	9.7E-11	1.4E-12	-5.0E-13	-1.1E-03	5.2E-08

$G_{th\ a}$	$G_{e\ a}$	$G_{th\ m}$	$G_{e\ m}$	f
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E-01
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.4E-08	-4.5E-08	6.0E-08	8.9E-09	2.3E-09

α	$Q_{0\,a}$	$E_{r\,a}$	$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	2.5E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	1.2E+01	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	3.6E-03	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.8E+01	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.6E-04
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.5E-07	-1.8E-09	-2.3E-11	4.6E-09	1.9E-12	1.4E-07

COI_m / COI_a	m_m	m_a	w_m	υ
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.4E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	2.5E-09	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.5E-09	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	2.1E-09	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.4E+00
7.0E-08	8.1E-06	-2.9E-07	1.5E-05	-6.9E-10

Irradiation and γ-spectrometry

end irradiation		9/12/2017	2.46 PM
irradiation time / s		21600	

library	CSF.Lib
calib	OR50_source2016_geom_cont_12052017.Clb
sm type	CSF.Lib (ROI32 Analysis)

Nuclide	Channel	Energy	Background
124Sb	6765.27	1691	9755
Co60	4691.96	1173.2	5220

	target	product
analite, a	^{123}Sb	^{124}Sb
monitor, m	^{59}Co	^{60}Co

Uncertainty budget of ρ_a

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
t_i		s	21600
μ		1	0.0445
$t_{1/2\ a}$		s	5201280
	λ_a	s^{-1}	1.3E-07
$t_{1/2\ m}$		s	1.7E+08
	λ_m	s^{-1}	4.2E-09
$t_{d\ a}$		s	2404405
$t_{c\ a}$		s	1292628
$t_{l\ a}$		s	1264268
$t_{d\ m}$		s	3722775
$t_{c\ m}$		s	797
$t_{l\ m}$		s	740
	δ_a	1	1.022
	δ_m	1	1.077
	ξ_a	1	1.00098
	ξ_m	1	1.00319
$n_{p\ a}$		1	2474
$n_{p\ m}$		1	137487
$k_{0\ Au}(a)$		1	0.01410
$k_{0\ Au}(m)$		1	1.3200
$G_{th\ a}$		1	1

$G_{e\,a}$		1	1
$G_{th\,m}$		1	1
$G_{e\,m}$		1	1
f		1	15.60
α		1	-0.0360
$Q_{0\,a}$		1	28.8
$E_{r\,a}$		eV	28.2
	$Q_{0\,a}(\alpha)$	1	32.45
$Q_{0\,m}$		1	1.993
$E_{r\,m}$		eV	136.0
	$Q_{0\,m}(\alpha)$	1	2.319
$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$		1	1.4022
COI_m / COI_a		1	1.030
m_m		g	0.00847
m_a		g	0.24000
w_m		g g^{-1}	0.004597
υ		mg L^{-1}	99.2
Y		[Y]	y
ρ_a		g mL^{-1}	4.01E-11

Uncertainty budget of $\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
a_1		Mev-1	-0.472
a_0		1	-3.229
a_{-1}		Mev	0.403
a_{-2}		Mev2	-0.0320
a_{-3}		Mev3	0.000573
$E_{\gamma\,m}$		MeV	1.17320
$E_{\gamma\,a}$		MeV	1.69100
Δd_a		mm	0
Δd_m		mm	0
	e_4	keV-4	-7.1E-11
	e_3	keV-3	5.2E-08
	e_2	keV-2	-1.4E-05
	e_1	keV-1	1.8E-03
	e_0	1	-4.5E-02
	d_1	keV-1	5.6E-06

	d_0	1	4.2E-02
$\delta\varepsilon_{r\,a}$		mm^{-1}	0.051
$\delta\varepsilon_{r\,m}$		mm^{-1}	0.048

Y	[Y]	y
$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	1	1.402

Uncertainty budget of COI_m / COI_a

Input Quantity	Quantity X_i	Unit $[X_i]$	Value x_i
a_1		Mev-1	-0.472
a_0		1	-3.229
a_{-1}		Mev	0.403
a_{-2}		Mev2	-0.0320
a_{-3}		Mev3	0.000573
	b_1	1	-0.571
	b_0	1	1.079
	c_2	1	-1.625
	c_1	1	6.678
	c_0	1	-7.006
$E_{\gamma 2\,m}$		keV	1332.5
$a_{\gamma 2\,m}$		1	1.000
$c_{\gamma 2\,m}$		1	1.000
$P/T_{\gamma 2\,m}$		1	0.197
$E_{\gamma 12\,a}$		keV	1691.00
$P_{\gamma 12\,a}$		1	47.60%
$E_{\gamma 24\,a}$		keV	602.70
$a_{\gamma 24\,a}$		1	1.000
$c_{\gamma 24\,a}$		1	1.000
$P/T_{\gamma 24\,a}$		1	0.310
$E_{\gamma 13\,a}$		keV	1045.10
$P_{\gamma 13\,a}$		1	1.82%
$E_{\gamma 23\,a}$		keV	645.90
$a_{\gamma 23\,a}$		1	1.000
$c_{\gamma 23\,a}$		1	1.000
$E_{\gamma 14\,a}$		keV	962.20
$P_{\gamma 14\,a}$		1	1.88%
$E_{\gamma 22\,a}$		keV	722.80
$a_{\gamma 22\,a}$		1	0.890

$c_{\gamma 22\ a}$			1	1.000
	Y	[Y]	y	
	COI_m / COI_a		1	1.030

Net area	Cnts/s	Uncert %	FWHM	source file	start counting
2474	0.002	8.61	1.924	OR50_20171025_CSF_s	10/10/2017
137487	185.919	0.32	1.798	OR50_20170925_Co_sa	10/25/2017

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
17	0.1%	2.6E-18	2.0E-33	0.0%	2.2E+04	4.0E-11
0.0005	1.1%	-2.0E-12	9.9E-31	0.0%	4.5E-02	4.0E-11
2592	0.0%	4.6E-18	1.4E-28	0.0%	5.2E+06	4.0E-11
6.6E-11	0.0%					
2.6E+04	0.0%	-2.4E-19	3.8E-29	0.0%	1.7E+08	4.0E-11
6.5E-13	0.0%					
35	0.0%	5.3E-18	3.4E-32	0.0%	2.4E+06	4.0E-11
0.3	0.0%	3.9E-18	1.3E-36	0.0%	1.3E+06	4.0E-11
0.3	0.0%	-3.3E-17	9.1E-35	0.0%	1.3E+06	4.0E-11
35	0.0%	-1.7E-19	3.4E-35	0.0%	3.7E+06	4.0E-11
0.3	0.0%	-2.1E-15	3.6E-31	0.0%	8.0E+02	4.0E-11
0.3	0.0%	5.6E-14	2.7E-28	0.0%	7.4E+02	4.0E-11
0.000	0.0%					
0.001	0.1%					
0.00001	0.0%					
0.00004	0.0%					
213	8.6%	1.6E-14	1.2E-23	77.6%	2.7E+03	4.4E-11
440	0.3%	-2.9E-16	1.6E-26	0.1%	1.4E+05	4.0E-11
0.00016	1.1%	-2.8E-09	1.9E-25	1.3%	1.4E-02	4.0E-11
0.0053	0.4%	3.0E-11	2.6E-26	0.2%	1.3E+00	4.0E-11
0	0.0%	-1.3E-11	0.0E+00	0.0%	1.0E+00	4.0E-11

0	0.0%	-2.7E-11	0.0E+00	0.0%	1.0E+00	4.0E-11
0	0.0%	3.5E-11	0.0E+00	0.0%	1.0E+00	4.0E-11
0	0.0%	5.2E-12	0.0E+00	0.0%	1.0E+00	4.0E-11
0.33	2.1%	1.4E-12	2.1E-25	1.4%	1.6E+01	4.1E-11
0.0064	17.8%	6.8E-11	1.9E-25	1.2%	-3.0E-02	4.1E-11
1.1	3.7%	-9.4E-13	1.0E-24	6.6%	3.0E+01	3.9E-11
1.8	6.4%	-3.4E-14	3.8E-27	0.0%	3.0E+01	4.0E-11
1.39	4.3%					
0.060	3.0%	2.7E-12	2.5E-26	0.2%	2.1E+00	4.0E-11
6.9	5.1%	1.1E-15	5.9E-29	0.0%	1.4E+02	4.0E-11
0.095	4.1%					
0.0387	2.8%	2.9E-11	1.2E-24	8.0%	1.4E+00	4.1E-11
0.008	0.8%	3.9E-11	9.2E-26	0.6%	1.0E+00	4.0E-11
0.00005	0.6%	4.7E-09	5.6E-26	0.4%	8.5E-03	4.0E-11
0.00005	0.0%	-1.7E-10	7.0E-29	0.0%	2.4E-01	4.0E-11
0.000046	1.0%	8.7E-09	1.6E-25	1.0%	4.6E-03	4.1E-11
1.2	1.2%	-4.0E-13	2.4E-25	1.5%	1.0E+02	4.0E-11

$u_c(y)$	$u_{c\,r}(y)$	Σ
3.9E-12	9.8%	100.0%

Std unc $u(x_i)$	Rel std unc $u_r(x_i)$	**Sensit coeff** c_i	Variance y $u^2_y(x_i)$	**Index**	Input for sensit coeff $x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	-7.3E-01	8.2E-04	55.0%	-4.3E-01	1.4E+00
0.057	1.8%	0.0E+00	0.0E+00	0.0%	-3.2E+00	1.4E+00
0.020	4.8%	3.7E-01	-1.6E-04	-10.4%	4.2E-01	1.4E+00
0.0022	6.9%	5.3E-01	2.3E-05	1.5%	-3.0E-02	1.4E+00
0.000075	13.1%	5.8E-01	-7.8E-07	-0.1%	6.5E-04	1.4E+00
0.00012	0.0%	-1.0E+00	1.4E-08	0.0%	1.2E+00	1.4E+00
0.00012	0.0%	8.4E-01	9.5E-09	0.0%	1.7E+00	1.4E+00
0.29		7.2E-02	4.3E-04	28.5%	2.9E-01	1.4E+00
0.29		-6.8E-02	3.8E-04	25.4%	2.9E-01	1.4E+00
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					

0.0000	0.0%					
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.7E-02	1.4E+00
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.4E-02	1.4E+00

$u_c(y)$	$u_{c\,r}(y)$			Σ
0.039	2.8%			100.0%

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	-0.0990	1.5E-05	24.5%	-4.3E-01	1.0E+00
0.057	1.8%	0.0377	6.8E-06	11.2%	-3.2E+00	1.0E+00
0.020	4.8%	0.2171	-1.1E-05	-18.2%	4.2E-01	1.0E+00
0.0022	6.9%	0.4785	2.3E-06	3.9%	-3.0E-02	1.0E+00
0.000075	13.1%	0.8856	-1.3E-07	-0.2%	6.5E-04	1.0E+00
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0.1	0.0%	0.0001	1.8E-10	0.0%	1.3E+03	1.0E+00
0.012	1.2%	-0.1714	3.9E-06	6.5%	1.0E+00	1.0E+00
0.012	1.2%	-0.1714	3.9E-06	6.5%	1.0E+00	1.0E+00
0.023	11.5%	0.8823	-1.1E-04	-173.7%	2.2E-01	1.0E+00
0.12	0.0%	0.0000	1.6E-13	0.0%	1.7E+03	1.0E+00
0.12%	0.2%	0.0122	2.0E-10	0.0%	4.8E-01	1.0E+00
0.12	0.0%	-0.0003	1.0E-09	0.0%	6.0E+02	1.0E+00
0.012	1.2%	0.2148	6.2E-06	10.2%	1.0E+00	1.0E+00
0.012	1.2%	0.2148	6.2E-06	10.2%	1.0E+00	1.0E+00
0.036	11.5%	-0.7075	1.3E-04	219.2%	3.5E-01	1.0E+00
0.12	0.0%	0.0000	7.7E-14	0.0%	1.0E+03	1.0E+00
0.12%	6.3%	-0.1683	3.8E-08	0.1%	1.9E-02	1.0E+00
0.12	0.0%	0.0000	1.8E-13	0.0%	6.5E+02	1.0E+00
0.012	1.2%	-0.0031	1.3E-09	0.0%	1.0E+00	1.0E+00
0.012	1.2%	-0.0031	1.3E-09	0.0%	1.0E+00	1.0E+00
0.12	0.0%	0.0000	7.1E-14	0.0%	9.6E+02	1.0E+00
0.12%	6.1%	-0.1467	2.9E-08	0.0%	2.0E-02	1.0E+00
0.12	0.0%	0.0000	1.2E-13	0.0%	7.2E+02	1.0E+00
0.012	1.3%	-0.0031	1.3E-09	0.0%	9.0E-01	1.0E+00

	0.012	1.2%	-0.0028	1.0E-09	0.0%		1.0E+00	1.0E+00
$u_c(y)$		$u_r(y)$		Σ				
	0.008	0.8%			100.0%			

	t_c / s	t_l / s	$t_{dead\ r}$ / %	t_d / s	t_c / $t_{1/2}$	t_d / $t_{1/2}$
10:39 AM	1292628	1264268	2.2%	2404405	0.25	0.5
4:52 PM	797	740	7.2%	3722775	0.00	0.0

Correlation matrix of ρ_a

x_i-u(x_i)	y(x_i-u(x_i))		t_i	μ	$t_{1/2\ a}$	$t_{1/2\ m}$
2.2E+04	4.0E-11	t_i	1	0	0	0
4.4E-02	4.0E-11	μ	0	1	0	0
5.2E+06	4.0E-11	$t_{1/2\ a}$	0	0	1	0
		$t_{1/2\ m}$	0	0	0	1
1.7E+08	4.0E-11	$t_{d\ a}$	0	0	0	0
		$t_{c\ a}$	0	0	0	0
2.4E+06	4.0E-11	$t_{l\ a}$	0	0	0	0
1.3E+06	4.0E-11	$t_{d\ m}$	0	0	0	0
1.3E+06	4.0E-11	$t_{c\ m}$	0	0	0	0
3.7E+06	4.0E-11	$t_{l\ m}$	0	0	0	0
8.0E+02	4.0E-11	$n_{p\ a}$	0	0	0	0
7.4E+02	4.0E-11	$n_{p\ m}$	0	0	0	0
		$k_{0\ Au}$(a)	0	0	0	0
		$k_{0\ Au}$(m)	0	0	0	0
		$G_{th\ a}$	0	0	0	0
		$G_{e\ a}$	0	0	0	0
2.3E+03	3.7E-11	$G_{th\ m}$	0	0	0	0
1.4E+05	4.0E-11	$G_{e\ m}$	0	0	0	0
1.4E-02	4.1E-11	f	0	0	0	0
1.3E+00	4.0E-11	α	0	0	0	0
1.0E+00	4.0E-11	$Q_{0\ a}$	0	0	0	0

1.0E+00	4.0E-11
1.0E+00	4.0E-11
1.0E+00	4.0E-11
1.5E+01	4.0E-11
-4.2E-02	4.0E-11
2.8E+01	4.1E-11
2.6E+01	4.0E-11
1.9E+00	4.0E-11
1.3E+02	4.0E-11
1.4E+00	3.9E-11
1.0E+00	4.0E-11
8.4E-03	4.0E-11
2.4E-01	4.0E-11
4.6E-03	4.0E-11
9.8E+01	4.1E-11

$E_{r\,a}$	0	0	0	0
$Q_{0\,m}$	0	0	0	0
$E_{r\,m}$	0	0	0	0
$\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}$	0	0	0	0
COI_m / COI_a	0	0	0	0
m_m	0	0	0	0
m_a	0	0	0	0
w_m	0	0	0	0
υ	0	0	0	0

Correlation matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	1.4E+00
-3.3E+00	1.4E+00
3.8E-01	1.4E+00
-3.4E-02	1.4E+00
5.0E-04	1.4E+00
1.2E+00	1.4E+00
1.7E+00	1.4E+00
-2.9E-01	1.4E+00
-2.9E-01	1.4E+00

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma\,m}$	0	0	0	0
$E_{\gamma\,a}$	0	0	0	0
Δd_a	0	0	0	0
Δd_m	0	0	0	0
$\delta\varepsilon_{r\,a}$	0	0	0	0
$\delta\varepsilon_{r\,m}$	0	0	0	0

4.5E-02	1.4E+00
4.3E-02	1.4E+00

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	1.0E+00
-3.3E+00	1.0E+00
3.8E-01	1.0E+00
-3.4E-02	1.0E+00
5.0E-04	1.0E+00
1.3E+03	1.0E+00
9.9E-01	1.0E+00
9.9E-01	1.0E+00
1.7E-01	1.0E+00
1.7E+03	1.0E+00
4.7E-01	1.0E+00
6.0E+02	1.0E+00
9.9E-01	1.0E+00
9.9E-01	1.0E+00
2.7E-01	1.1E+00
1.0E+03	1.0E+00
1.7E-02	1.0E+00
6.5E+02	1.0E+00
9.9E-01	1.0E+00
9.9E-01	1.0E+00
9.6E+02	1.0E+00
1.8E-02	1.0E+00
7.2E+02	1.0E+00
8.8E-01	1.0E+00

Correlation matrix of COI_m / COI_a

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma 2\ m}$	0	0	0	0
$a_{\gamma 2\ m}$	0	0	0	0
$c_{\gamma 2\ m}$	0	0	0	0
$P/T_{\gamma 2\ m}$	0	0	0	0
$E_{\gamma 12\ a}$	0	0	0	0
$P_{\gamma 12\ a}$	0	0	0	0
$E_{\gamma 24\ a}$	0	0	0	0
$a_{\gamma 24\ a}$	0	0	0	0
$c_{\gamma 24\ a}$	0	0	0	0
$P/T_{\gamma 24\ a}$	0	0	0	0
$E_{\gamma 13\ a}$	0	0	0	0
$P_{\gamma 13\ a}$	0	0	0	0
$E_{\gamma 23\ a}$	0	0	0	0
$a_{\gamma 23\ a}$	0	0	0	0
$c_{\gamma 23\ a}$	0	0	0	0
$E_{\gamma 14\ a}$	0	0	0	0
$P_{\gamma 14\ a}$	0	0	0	0
$E_{\gamma 22\ a}$	0	0	0	0
$a_{\gamma 22\ a}$	0	0	0	0
$c_{\gamma 22\ a}$	0	0	0	0

9.9E-01 1.0E+00

$t_{d\,a}$	$t_{c\,a}$	$t_{l\,a}$	$t_{d\,m}$	$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

a_{-3}	$E_{\gamma m}$	$E_{\gamma a}$	Δd_a	Δd_m	$\delta\varepsilon_{r a}$	$\delta\varepsilon_{r m}$	c_i
0.748	0	0	0	0	0	0	-7.3E-01
-0.848	0	0	0	0	0	0	0.0E+00
0.957	0	0	0	0	0	0	3.7E-01
-0.993	0	0	0	0	0	0	5.3E-01
1.000	0	0	0	0	0	0	5.8E-01
0	1	0	0	0	0	0	-1.0E+00
0	0	1	0	0	0	0	8.4E-01
0	0	0	1	0	0	0	7.2E-02
0	0	0	0	1	0	0	-6.8E-02
0	0	0	0	0	1	1	0.0E+00
0	0	0	0	0	1	1	0.0E+00

a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	$E_{\gamma 12\ a}$	$P_{\gamma 12\ a}$	$E_{\gamma 24\ a}$	$a_{\gamma 24\ a}$
0.748	0	0	0	0	0	0	0	0
-0.848	0	0	0	0	0	0	0	0
0.957	0	0	0	0	0	0	0	0
-0.993	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

$k_{0\ Au}(m)$	$G_{th\ a}$	$G_{e\ a}$	$G_{th\ m}$	$G_{e\ m}$	f	α	$Q_{0\ a}$	$E_{r\ a}$	$Q_{0\ m}$
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	1	0	0

0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

Covariance matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

	a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma\,m}$	$E_{\gamma\,a}$	Δd_a
a_1	1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00	0.0E+00
a_0	-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00	0.0E+00
a_{-1}	7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00	0.0E+00
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00	0.0E+00
a_{-3}	2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00	0.0E+00
$E_{\gamma\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08	0.0E+00	0.0E+00
$E_{\gamma\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08	0.0E+00
Δd_a	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.3E-02
Δd_m	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
c_i	-7.3E-01	0.0E+00	3.7E-01	5.3E-01	5.8E-01	-1.0E+00	8.4E-01	7.2E-02

$c_{\gamma 24\ a}$	$P/T_{\gamma 24\ a}$	$E_{\gamma 13\ a}$	$P_{\gamma 13\ a}$	$E_{\gamma 23\ a}$	$a_{\gamma 23\ a}$	$c_{\gamma 23\ a}$	$E_{\gamma 14\ a}$	$P_{\gamma 14\ a}$	$E_{\gamma 22\ a}$
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	COI_m / COI_a	m_m	m_a	w_m	υ
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	1	0	0	0	0
0	0	0	1	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	1	0
0	0	0	0	0	0	1

Δd_m	$\delta\varepsilon_{r\,a}$	$\delta\varepsilon_{r\,m}$
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00
0.0E+00	3.5E-05	3.3E-05
0.0E+00	3.3E-05	3.1E-05
-6.8E-02	0.0E+00	0.0E+00

$a_{\gamma22\ a}$	$c_{\gamma22\ a}$	c_i
0	0	-9.9E-02
0	0	3.8E-02
0	0	2.2E-01
0	0	4.8E-01
0	0	8.9E-01
0	0	1.2E-04
0	0	-1.7E-01
0	0	-1.7E-01
0	0	8.8E-01
0	0	-3.5E-06
0	0	1.2E-02
0	0	-2.8E-04
0	0	2.1E-01
0	0	2.1E-01
0	0	-7.1E-01
0	0	2.4E-06
0	0	-1.7E-01
0	0	3.7E-06
0	0	-3.1E-03
0	0	-3.1E-03
0	0	2.3E-06
0	0	-1.5E-01
0	0	3.0E-06
1	0	-3.1E-03
0	1	-2.8E-03

Covariance matrix of COI_m/COI_a

	a_1	a_0
a_1	1.9E-03	-2.4E-03
a_0	-2.4E-03	3.2E-03
a_{-1}	7.5E-04	-1.1E-03
a_{-2}	-7.7E-05	1.1E-04
a_{-3}	2.4E-06	-3.6E-06
$E_{\gamma2\ m}$	0.0E+00	0.0E+00
$a_{\gamma2\ m}$	0.0E+00	0.0E+00
$c_{\gamma2\ m}$	0.0E+00	0.0E+00
$P/T_{\gamma2\ m}$	0.0E+00	0.0E+00
$E_{\gamma12\ a}$	0.0E+00	0.0E+00
$P_{\gamma12\ a}$	0.0E+00	0.0E+00
$E_{\gamma24\ a}$	0.0E+00	0.0E+00
$a_{\gamma24\ a}$	0.0E+00	0.0E+00
$c_{\gamma24\ a}$	0.0E+00	0.0E+00
$P/T_{\gamma24\ a}$	0.0E+00	0.0E+00
$E_{\gamma13\ a}$	0.0E+00	0.0E+00
$P_{\gamma13\ a}$	0.0E+00	0.0E+00
$E_{\gamma23\ a}$	0.0E+00	0.0E+00
$a_{\gamma23\ a}$	0.0E+00	0.0E+00
$c_{\gamma23\ a}$	0.0E+00	0.0E+00
$E_{\gamma14\ a}$	0.0E+00	0.0E+00
$P_{\gamma14\ a}$	0.0E+00	0.0E+00
$E_{\gamma22\ a}$	0.0E+00	0.0E+00
$a_{\gamma22\ a}$	0.0E+00	0.0E+00
$c_{\gamma22\ a}$	0.0E+00	0.0E+00
c_i	-9.9E-02	3.8E-02

Covariance matrix of ρ_a

c_i		t_i	μ	$t_{1/2\ a}$	$t_{1/2\ m}$	$t_{d\ a}$	$t_{c\ a}$
2.6E-18	t_i	3.0E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.0E-12	μ	0.0E+00	2.5E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.6E-18	$t_{1/2\ a}$	0.0E+00	0.0E+00	6.7E+06	0.0E+00	0.0E+00	0.0E+00
-2.4E-19	$t_{1/2\ m}$	0.0E+00	0.0E+00	0.0E+00	6.7E+08	0.0E+00	0.0E+00
5.3E-18	$t_{d\ a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E+03	0.0E+00
3.9E-18	$t_{c\ a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.3E-02
-3.3E-17	$t_{l\ a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.7E-19	$t_{d\ m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.1E-15	$t_{c\ m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
5.6E-14	$t_{l\ m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.6E-14	$n_{p\ a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.9E-16	$n_{p\ m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.8E-09	$k_{0\ Au}(a)$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
3.0E-11	$k_{0\ Au}(m)$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.3E-11	$G_{th\ a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.7E-11	$G_{e\ a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
3.5E-11	$G_{th\ m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
5.2E-12	$G_{e\ m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.4E-12	f	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
6.8E-11	α	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-9.4E-13	$Q_{0\ a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

-3.4E-14	$E_{r\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.7E-12	$Q_{0\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.1E-15	$E_{r\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.9E-11	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
3.9E-11	COI_m / COI_a	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.7E-09	m_m	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.7E-10	m_a	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.7E-09	w_m	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-4.0E-13	υ	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	$\mathbf{c}_i$	2.6E-18	-2.0E-12	4.6E-18	-2.4E-19	5.3E-18	3.9E-18

a_{-1}	a_{-2}	a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	$E_{\gamma 12\ a}$	$P_{\gamma 12\ a}$
7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-02	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-06
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.1E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

2.2E-01	4.8E-01	8.9E-01	1.2E-04	-1.7E-01	-1.7E-01	8.8E-01	-3.5E-06	1.2E-02

$t_{l\ a}$	$t_{d\ m}$	$t_{c\ m}$	$t_{l\ m}$	$n_{p\ a}$	$n_{p\ m}$	$k_{0\ Au}(a)$	$k_{0\ Au}(m)$	$G_{th\ a}$	$G_{e\ a}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	1.2E+03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.5E+04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.9E+05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.4E-08	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.8E-05	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-3.3E-17	-1.7E-19	-2.1E-15	5.6E-14	1.6E-14	-2.9E-16	-2.8E-09	3.0E-11	-1.3E-11	-2.7E-11

$E_{\gamma 24\ a}$	$a_{\gamma 24\ a}$	$c_{\gamma 24\ a}$	$P/T_{\gamma 24\ a}$	$E_{\gamma 13\ a}$	$P_{\gamma 13\ a}$	$E_{\gamma 23\ a}$	$a_{\gamma 23\ a}$	$c_{\gamma 23\ a}$	$E_{\gamma 14\ a}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	8.1E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	1.3E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.3E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-02
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.8E-04	2.1E-01	2.1E-01	-7.1E-01	2.4E-06	-1.7E-01	3.7E-06	-3.1E-03	-3.1E-03	2.3E-06

$G_{th\ m}$	$G_{e\ m}$	f	α	$Q_{0\ a}$	$E_{r\ a}$	$Q_{0\ m}$	$E_{r\ m}$	$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.1E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	4.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.3E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.6E-03	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.8E+01	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.5E-03
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
3.5E-11	5.2E-12	1.4E-12	6.8E-11	-9.4E-13	-3.4E-14	2.7E-12	1.1E-15	2.9E-11

$P_{\gamma 14\ a}$	$E_{\gamma 22\ a}$	$a_{\gamma 22\ a}$	$c_{\gamma 22\ a}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.3E-06	0.0E+00	0.0E+00	0.0E+00
0.0E+00	1.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.3E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.3E-04
-1.5E-01	3.0E-06	-3.1E-03	-2.8E-03

COI_m / COI_a	m_m	m_a	w_m	υ
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
6.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	2.5E-09	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.5E-09	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	2.1E-09	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.4E+00
3.9E-11	4.7E-09	-1.7E-10	8.7E-09	-4.0E-13

Irradiation and γ-spectrometry

end irradiation		9/12/2017	2.46 PM
irradiation time / s		21600	

library	CSF.Lib
calib	OR50_source2016_geom_cont_12052017.Clb
sm type	CSF.Lib (ROI32 Analysis)

Nuclide	Channel	Energy	Background
46Sc	3555.94	889.3	98862
Co60	4691.96	1173.2	5220

	target	product
analite, a	^{45}Sc	^{46}Sc
monitor, m	^{59}Co	^{60}Co

Uncertainty budget of ρ_a

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
t_i		s	21600
μ		1	0.0445
$t_{1/2\,a}$		s	7242912
	λ_a	s^{-1}	9.6E-08
$t_{1/2\,m}$		s	1.7E+08
	λ_m	s^{-1}	4.2E-09
$t_{d\,a}$		s	2404405
$t_{c\,a}$		s	1292628
$t_{l\,a}$		s	1264268
$t_{d\,m}$		s	3722775
$t_{c\,m}$		s	797
$t_{l\,m}$		s	740
	δ_a	1	1.022
	δ_m	1	1.077
	ξ_a	1	1.00098
	ξ_m	1	1.00319
$n_{p\,a}$		1	130702
$n_{p\,m}$		1	137487
$k_{0\,Au}(a)$		1	1.2200
$k_{0\,Au}(m)$		1	1.3200
$G_{th\,a}$		1	1

$G_{e\ a}$		1	1
$G_{th\ m}$		1	1
$G_{e\ m}$		1	1
f		1	15.60
α		1	-0.0360
$Q_{0\ a}$		1	0.430
$E_{r\ a}$		eV	5130
	$Q_{0\ a}(\alpha)$	1	0.45
$Q_{0\ m}$		1	1.993
$E_{r\ m}$		eV	136.0
	$Q_{0\ m}(\alpha)$	1	2.319
$\varepsilon_{p\ m}{}^{geo} / \varepsilon_{p\ a}{}^{geo}$		1	0.7968
COI_m / COI_a		1	1.009
m_m		g	0.00847
m_a		g	0.24000
w_m		$g\ g^{-1}$	0.004597
υ		$mg\ L^{-1}$	99.2
Y		[Y]	y
ρ_a		$g\ mL^{-1}$	5.06E-11

Uncertainty budget of $\varepsilon_{p\ m}{}^{geo} / \varepsilon_{p\ a}{}^{geo}$

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
a_1		Mev-1	-0.472
a_0		1	-3.229
a_{-1}		Mev	0.403
a_{-2}		Mev2	-0.0320
a_{-3}		Mev3	0.000573
$E_{\gamma\ m}$		MeV	1.17320
$E_{\gamma\ a}$		MeV	0.88930
Δd_a		mm	0
Δd_m		mm	0
	e_4	keV-4	-7.1E-11
	e_3	keV-3	5.2E-08
	e_2	keV-2	-1.4E-05
	e_1	keV-1	1.8E-03
	e_0	1	-4.5E-02
	d_1	keV-1	5.6E-06

	d_0		1	4.2E-02
$\delta\varepsilon_{r\ a}$		mm^{-1}		0.047
$\delta\varepsilon_{r\ m}$		mm^{-1}		0.048

Y	[Y]	y	
$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$	1		0.797

Uncertainty budget of COI_m / COI_a

Input Quantity	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i	
a_1		Mev-1		-0.472
a_0			1	-3.229
a_{-1}		Mev		0.403
a_{-2}		Mev2		-0.0320
a_{-3}		Mev3		0.000573
	b_1		1	-0.571
	b_0		1	1.079
	c_2		1	-1.625
	c_1		1	6.678
	c_0		1	-7.006
$E_{\gamma 2\ m}$		keV		1332.5
$a_{\gamma 2\ m}$			1	1.000
$c_{\gamma 2\ m}$			1	1.000
$P/T_{\gamma 2\ m}$			1	0.197
$E_{\gamma 1\ a}$		keV		1120.5
$P_{\gamma 1\ a}$			1	99.99%
$P/T_{\gamma 1\ a}$			1	0.217
$a_{\gamma 2\ a}$			1	1.000
$c_{\gamma 2\ a}$			1	1.000
$P_{\gamma 2\ a}$			1	99.98%

Y	[Y]	y	
COI_m / COI_a		1	1.009

Net area	Cnts/s	Uncert %	FWHM	source file	start counting
130702	0.103	0.61	1.615	OR50_20171025_CSF_s	10/10/2017
137487	185.919	0.32	1.798	OR50_20170925_Co_sa	10/25/2017

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
17	0.1%	2.3E-18	1.6E-33	0.0%	2.2E+04	5.1E-11
0.0005	1.1%	-2.5E-12	1.6E-30	0.0%	4.5E-02	5.1E-11
1728	0.0%	5.0E-18	7.3E-29	0.0%	7.2E+06	5.1E-11
2.3E-11	0.0%					
2.6E+04	0.0%	-3.0E-19	6.0E-29	0.0%	1.7E+08	5.1E-11
6.5E-13	0.0%					
35	0.0%	4.8E-18	2.8E-32	0.0%	2.4E+06	5.1E-11
0.3	0.0%	4.1E-18	1.4E-36	0.0%	1.3E+06	5.1E-11
0.3	0.0%	-4.2E-17	1.5E-34	0.0%	1.3E+06	5.1E-11
35	0.0%	-2.1E-19	5.3E-35	0.0%	3.7E+06	5.1E-11
0.3	0.0%	-2.6E-15	5.7E-31	0.0%	8.0E+02	5.1E-11
0.3	0.0%	7.1E-14	4.2E-28	0.0%	7.4E+02	5.1E-11
0.000	0.0%					
0.001	0.1%					
0.00001	0.0%					
0.00004	0.0%					
797	0.6%	3.9E-16	9.5E-26	4.1%	1.3E+05	5.1E-11
440	0.3%	-3.7E-16	2.6E-26	1.1%	1.4E+05	5.0E-11
0.0049	0.4%	-4.2E-11	4.1E-26	1.7%	1.2E+00	5.0E-11
0.0053	0.4%	3.8E-11	4.1E-26	1.7%	1.3E+00	5.1E-11
0	0.0%	-4.9E-11	0.0E+00	0.0%	1.0E+00	5.1E-11

0	0.0%	-1.4E-12	0.0E+00	0.0%	1.0E+00	5.1E-11
0	0.0%	4.4E-11	0.0E+00	0.0%	1.0E+00	5.1E-11
0	0.0%	6.6E-12	0.0E+00	0.0%	1.0E+00	5.1E-11
0.33	2.1%	-3.3E-13	1.2E-26	0.5%	1.6E+01	5.1E-11
0.0064	17.8%	-2.6E-11	2.7E-26	1.2%	-3.0E-02	5.0E-11
0.086	20.0%	-4.3E-12	1.4E-25	5.8%	5.2E-01	5.0E-11
872	17.0%	-3.0E-20	7.0E-34	0.0%	6.0E+03	5.1E-11
0.12	25.8%					
0.060	3.0%	3.4E-12	4.1E-26	1.7%	2.1E+00	5.1E-11
6.9	5.1%	1.4E-15	9.4E-29	0.0%	1.4E+02	5.1E-11
0.095	4.1%					
0.0169	2.1%	6.4E-11	1.2E-24	49.3%	8.1E-01	5.2E-11
0.004	0.4%	5.0E-11	4.8E-26	2.0%	1.0E+00	5.1E-11
0.00005	0.6%	6.0E-09	8.9E-26	3.8%	8.5E-03	5.1E-11
0.00005	0.0%	-2.1E-10	1.1E-28	0.0%	2.4E-01	5.1E-11
0.000046	1.0%	1.1E-08	2.6E-25	10.9%	4.6E-03	5.1E-11
1.2	1.2%	-5.1E-13	3.8E-25	16.0%	1.0E+02	5.0E-11

$u_c(y)$	$u_{c\,r}(y)$	Σ
1.5E-12	3.0%	100.0%

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	2.3E-01	6.7E-05	23.4%	-4.3E-01	8.1E-01
0.057	1.8%	0.0E+00	0.0E+00	0.0%	-3.2E+00	8.0E-01
0.020	4.8%	-2.2E-01	-2.3E-05	-7.9%	4.2E-01	7.9E-01
0.0022	6.9%	-4.3E-01	4.4E-06	1.5%	-3.0E-02	8.0E-01
0.000075	13.1%	-6.4E-01	-2.0E-07	-0.1%	6.5E-04	8.0E-01
0.00012	0.0%	-5.8E-01	4.5E-09	0.0%	1.2E+00	8.0E-01
0.00012	0.0%	7.1E-01	6.8E-09	0.0%	8.9E-01	8.0E-01
0.29		3.7E-02	1.2E-04	40.2%	2.9E-01	8.1E-01
0.29		-3.8E-02	1.2E-04	42.9%	2.9E-01	7.9E-01
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					

0.0000	0.0%					
0.005	11.5%	0.0E+00	0.0E+00	0.0%	5.2E-02	8.0E-01
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.4E-02	8.0E-01
$u_c(y)$	$u_{c\ r}(y)$			Σ		
0.017	2.1%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	c_i	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	-0.0240	1.2E-06	6.2%	-4.3E-01	1.0E+00
0.057	1.8%	0.0104	6.4E-07	3.3%	-3.2E+00	1.0E+00
0.020	4.8%	0.0331	-6.1E-07	-3.2%	4.2E-01	1.0E+00
0.0022	6.9%	0.0474	8.8E-08	0.5%	-3.0E-02	1.0E+00
0.000075	13.1%	0.0557	-3.2E-09	0.0%	6.5E-04	1.0E+00
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0.1	0.0%	0.0001	1.7E-10	0.0%	1.3E+03	1.0E+00
0.012	1.2%	-0.1678	3.8E-06	19.7%	1.0E+00	1.0E+00
0.012	1.2%	-0.1678	3.8E-06	19.7%	1.0E+00	1.0E+00
0.023	11.5%	0.8639	-2.6E-05	-136.3%	2.2E-01	1.0E+00
0.12	0.0%	-0.0001	2.4E-10	0.0%	1.1E+03	1.0E+00
0.01%	0.0%	0.1782	4.2E-10	0.0%	1.0E+00	1.0E+00
0.025	11.5%	-0.8352	2.8E-05	145.4%	2.4E-01	9.9E-01
0.012	1.2%	0.1782	4.2E-06	22.2%	1.0E+00	1.0E+00
0.012	1.2%	0.1782	4.2E-06	22.2%	1.0E+00	1.0E+00
0.12%	0.1%	-0.1782	4.2E-08	0.2%	1.0E+00	1.0E+00
$u_c(y)$	$u_r(y)$			Σ		
0.004	0.4%			100.0%		

	t_c / s	t_l / s	$t_{dead\ r}$ / %	t_d / s	t_c / $t_{1/2}$	t_d / $t_{1/2}$
10:39 AM	1292628	1264268	2.2%	2404405	0.18	0.3
4:52 PM	797	740	7.2%	3722775	0.00	0.0

Correlation matrix of ρ_a

x_i-u(x_i)	y(x_i-u(x_i))		t_i	μ	$t_{1/2\ a}$	$t_{1/2\ m}$
2.2E+04	5.1E-11	t_i	1	0	0	0
4.4E-02	5.1E-11	μ	0	1	0	0
7.2E+06	5.1E-11	$t_{1/2\ a}$	0	0	1	0
		$t_{1/2\ m}$	0	0	0	1
1.7E+08	5.1E-11	$t_{d\ a}$	0	0	0	0
		$t_{c\ a}$	0	0	0	0
2.4E+06	5.1E-11	$t_{l\ a}$	0	0	0	0
1.3E+06	5.1E-11	$t_{d\ m}$	0	0	0	0
1.3E+06	5.1E-11	$t_{c\ m}$	0	0	0	0
3.7E+06	5.1E-11	$t_{l\ m}$	0	0	0	0
8.0E+02	5.1E-11	$n_{p\ a}$	0	0	0	0
7.4E+02	5.1E-11	$n_{p\ m}$	0	0	0	0
		$k_{0\ Au}$(a)	0	0	0	0
		$k_{0\ Au}$(m)	0	0	0	0
		$G_{th\ a}$	0	0	0	0
		$G_{e\ a}$	0	0	0	0
1.3E+05	5.0E-11	$G_{th\ m}$	0	0	0	0
1.4E+05	5.1E-11	$G_{e\ m}$	0	0	0	0
1.2E+00	5.1E-11	f	0	0	0	0
1.3E+00	5.0E-11	α	0	0	0	0
1.0E+00	5.1E-11	$Q_{0\ a}$	0	0	0	0

1.0E+00	5.1E-11
1.0E+00	5.1E-11
1.0E+00	5.1E-11
1.5E+01	5.1E-11
-4.2E-02	5.1E-11
3.4E-01	5.1E-11
4.3E+03	5.1E-11
1.9E+00	5.0E-11
1.3E+02	5.1E-11
7.8E-01	5.0E-11
1.0E+00	5.0E-11
8.4E-03	5.0E-11
2.4E-01	5.1E-11
4.6E-03	5.0E-11
9.8E+01	5.1E-11

$E_{r\,a}$	0	0	0	0
$Q_{0\,m}$	0	0	0	0
$E_{r\,m}$	0	0	0	0
$\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}$	0	0	0	0
COI_m / COI_a	0	0	0	0
m_m	0	0	0	0
m_a	0	0	0	0
w_m	0	0	0	0
υ	0	0	0	0

Correlation matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	7.9E-01
-3.3E+00	8.0E-01
3.8E-01	8.0E-01
-3.4E-02	8.0E-01
5.0E-04	8.0E-01
1.2E+00	8.0E-01
8.9E-01	8.0E-01
-2.9E-01	7.9E-01
-2.9E-01	8.1E-01

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma\,m}$	0	0	0	0
$E_{\gamma\,a}$	0	0	0	0
Δd_a	0	0	0	0
Δd_m	0	0	0	0
$\delta\varepsilon_{r\,a}$	0	0	0	0
$\delta\varepsilon_{r\,m}$	0	0	0	0

4.1E-02	8.0E-01
4.3E-02	8.0E-01

Correlation matrix of COI_m / COI_a

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	1.0E+00
-3.3E+00	1.0E+00
3.8E-01	1.0E+00
-3.4E-02	1.0E+00
5.0E-04	1.0E+00
1.3E+03	1.0E+00
9.9E-01	1.0E+00
9.9E-01	1.0E+00
1.7E-01	9.9E-01
1.1E+03	1.0E+00
1.0E+00	1.0E+00
1.9E-01	1.0E+00
9.9E-01	1.0E+00
9.9E-01	1.0E+00
1.0E+00	1.0E+00

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma 2\ m}$	0	0	0	0
$a_{\gamma 2\ m}$	0	0	0	0
$c_{\gamma 2\ m}$	0	0	0	0
$P/T_{\gamma 2\ m}$	0	0	0	0
$E_{\gamma 1\ a}$	0	0	0	0
$P_{\gamma 1\ a}$	0	0	0	0
$P/T_{\gamma 1\ a}$	0	0	0	0
$a_{\gamma 2\ a}$	0	0	0	0
$c_{\gamma 2\ a}$	0	0	0	0
$P_{\gamma 2\ a}$	0	0	0	0

$t_{d\,a}$	$t_{c\,a}$	$t_{l\,a}$	$t_{d\,m}$	$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

a_{-3}	$E_{\gamma m}$	$E_{\gamma a}$	Δd_a	Δd_m	$\delta\varepsilon_{r a}$	$\delta\varepsilon_{r m}$	c_i
0.748	0	0	0	0	0	0	2.3E-01
-0.848	0	0	0	0	0	0	0.0E+00
0.957	0	0	0	0	0	0	-2.2E-01
-0.993	0	0	0	0	0	0	-4.3E-01
1.000	0	0	0	0	0	0	-6.4E-01
0	1	0	0	0	0	0	-5.8E-01
0	0	1	0	0	0	0	7.1E-01
0	0	0	1	0	0	0	3.7E-02
0	0	0	0	1	0	0	-3.8E-02
0	0	0	0	0	1	1	0.0E+00
0	0	0	0	0	1	1	0.0E+00

a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	$E_{\gamma 1\ a}$	$P_{\gamma 1\ a}$	$P/T_{\gamma 1\ a}$	$a_{\gamma 2\ a}$
0.748	0	0	0	0	0	0	0	0
-0.848	0	0	0	0	0	0	0	0
0.957	0	0	0	0	0	0	0	0
-0.993	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	1	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	1	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

$k_{0\ Au}(m)$	$G_{th\ a}$	$G_{e\ a}$	$G_{th\ m}$	$G_{e\ m}$	f	α	$Q_{0\ a}$	$E_{r\ a}$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0

0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Covariance matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

	a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma\,m}$	$E_{\gamma\,a}$
a_1	1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00
a_0	-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00
a_{-1}	7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00
a_{-3}	2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00
$E_{\gamma\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08	0.0E+00
$E_{\gamma\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08
Δd_a	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Δd_m	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
c_i	2.3E-01	0.0E+00	-2.2E-01	-4.3E-01	-6.4E-01	-5.8E-01	7.1E-01

$c_{\gamma 2\ a}$	$P_{\gamma 2\ a}$	c_i
0	0	-2.4E-02
0	0	1.0E-02
0	0	3.3E-02
0	0	4.7E-02
0	0	5.6E-02
0	0	1.1E-04
0	0	-1.7E-01
0	0	-1.7E-01
0	0	8.6E-01
0	0	-1.3E-04
0	0	1.8E-01
0	0	-8.4E-01
0	0	1.8E-01
1	0	1.8E-01
0	1	-1.8E-01

Covariance matrix of COI_m/COI_a

	a_1	a_0	a_{-1}
a_1	1.9E-03	-2.4E-03	7.5E-04
a_0	-2.4E-03	3.2E-03	-1.1E-03
a_{-1}	7.5E-04	-1.1E-03	3.8E-04
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05
a_{-3}	2.4E-06	-3.6E-06	1.4E-06
$E_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$a_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$c_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$P/T_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$E_{\gamma 1\ a}$	0.0E+00	0.0E+00	0.0E+00
$P_{\gamma 1\ a}$	0.0E+00	0.0E+00	0.0E+00
$P/T_{\gamma 1\ a}$	0.0E+00	0.0E+00	0.0E+00
$a_{\gamma 2\ a}$	0.0E+00	0.0E+00	0.0E+00
$c_{\gamma 2\ a}$	0.0E+00	0.0E+00	0.0E+00
$P_{\gamma 2\ a}$	0.0E+00	0.0E+00	0.0E+00
c_i	-2.4E-02	1.0E-02	3.3E-02

$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	COI_m / COI_a	m_m	m_a	w_m
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

0	0	0	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	1	0	0	0	0
0	0	0	1	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	1	0
0	0	0	0	0	0	1
0	0	0	0	0	0	0

Δd_a	Δd_m	$\delta\varepsilon_{r\ a}$	$\delta\varepsilon_{r\ m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.9E-05	3.0E-05
0.0E+00	0.0E+00	3.0E-05	3.1E-05
3.7E-02	-3.8E-02	0.0E+00	0.0E+00

a_{-2}	a_{-3}	$E_{\gamma 2\,m}$	$a_{\gamma 2\,m}$	$c_{\gamma 2\,m}$	$P/T_{\gamma 2\,m}$	$E_{\gamma 1\,a}$
-7.7E-05	2.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.1E-04	-3.6E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-4.3E-05	1.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.9E-06	-1.7E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.7E-07	5.7E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-02
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.7E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.7E-02	5.6E-02	1.1E-04	-1.7E-01	-1.7E-01	8.6E-01	-1.3E-04

Covariance matrix of ρ_a

υ	c_i		t_i	μ
0	2.3E-18	t_i	3.0E+02	0.0E+00
0	-2.5E-12	μ	0.0E+00	2.5E-07
0	5.0E-18	$t_{1/2\ a}$	0.0E+00	0.0E+00
0	-3.0E-19	$t_{1/2\ m}$	0.0E+00	0.0E+00
0	4.8E-18	$t_{d\ a}$	0.0E+00	0.0E+00
0	4.1E-18	$t_{c\ a}$	0.0E+00	0.0E+00
0	-4.2E-17	$t_{l\ a}$	0.0E+00	0.0E+00
0	-2.1E-19	$t_{d\ m}$	0.0E+00	0.0E+00
0	-2.6E-15	$t_{c\ m}$	0.0E+00	0.0E+00
0	7.1E-14	$t_{l\ m}$	0.0E+00	0.0E+00
0	3.9E-16	$n_{p\ a}$	0.0E+00	0.0E+00
0	-3.7E-16	$n_{p\ m}$	0.0E+00	0.0E+00
0	-4.2E-11	$k_{0\ Au}(a)$	0.0E+00	0.0E+00
0	3.8E-11	$k_{0\ Au}(m)$	0.0E+00	0.0E+00
0	-4.9E-11	$G_{th\ a}$	0.0E+00	0.0E+00
0	-1.4E-12	$G_{e\ a}$	0.0E+00	0.0E+00
0	4.4E-11	$G_{th\ m}$	0.0E+00	0.0E+00
0	6.6E-12	$G_{e\ m}$	0.0E+00	0.0E+00
0	-3.3E-13	f	0.0E+00	0.0E+00
0	-2.6E-11	α	0.0E+00	0.0E+00
0	-4.3E-12	$Q_{0\ a}$	0.0E+00	0.0E+00

0	-3.0E-20	$E_{r\,a}$	0.0E+00	0.0E+00
0	3.4E-12	$Q_{0\,m}$	0.0E+00	0.0E+00
0	1.4E-15	$E_{r\,m}$	0.0E+00	0.0E+00
0	6.4E-11	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	0.0E+00	0.0E+00
0	5.0E-11	COI_m / COI_a	0.0E+00	0.0E+00
0	6.0E-09	m_m	0.0E+00	0.0E+00
0	-2.1E-10	m_a	0.0E+00	0.0E+00
0	1.1E-08	w_m	0.0E+00	0.0E+00
1	-5.1E-13	υ	0.0E+00	0.0E+00
		$\mathbf{c}_i$	2.3E-18	-2.5E-12

$P_{\gamma l\ a}$	$P/T_{\gamma 1\ a}$	$a_{\gamma 2\ a}$	$c_{\gamma 2\ a}$	$P_{\gamma 2\ a}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	5.7E-04	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.3E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	6.3E-04	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-06
1.8E-01	-8.4E-01	1.8E-01	1.8E-01	-1.8E-01

$t_{1/2\ a}$	$t_{1/2\ m}$	$t_{d\ a}$	$t_{c\ a}$	$t_{l\ a}$	$t_{d\ m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
3.0E+06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	6.7E+08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.2E+03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E+03
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
5.0E-18	-3.0E-19	4.8E-18	4.1E-18	-4.2E-17	-2.1E-19

$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$	$k_{0\,Au}(m)$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	6.4E+05	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.9E+05	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.4E-05	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.8E-05
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.6E-15	7.1E-14	3.9E-16	-3.7E-16	-4.2E-11	3.8E-11

$G_{th\ a}$	$G_{e\ a}$	$G_{th\ m}$	$G_{e\ m}$	f
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E-01
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-4.9E-11	-1.4E-12	4.4E-11	6.6E-12	-3.3E-13

α	$Q_{0\,a}$	$E_{r\,a}$	$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	7.4E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	7.6E+05	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	3.6E-03	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.8E+01	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.9E-04
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.6E-11	-4.3E-12	-3.0E-20	3.4E-12	1.4E-15	6.4E-11

COI_m / COI_a	m_m	m_a	w_m	υ
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.9E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	2.5E-09	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.5E-09	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	2.1E-09	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.4E+00
5.0E-11	6.0E-09	-2.1E-10	1.1E-08	-5.1E-13

Irradiation and γ-spectrometry

end irradiation		9/12/2017	2.46 PM
irradiation time / s		21600	

library	CSF.Lib
calib	OR50_source2016_geom_cont_12052017.Clb
sm type	CSF.Lib (ROI32 Analysis)

Nuclide	Channel	Energy	Background
86Rb	4307.77	1077	49054
Co60	4691.96	1173.2	5220

	target	product
analite, a	^{85}Rb	^{86}Rb
monitor, m	^{59}Co	^{60}Co

Uncertainty budget of ρ_a

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
t_i		s	21600
μ		1	0.0445
$t_{1/2\ a}$		s	1609632
	λ_a	s^{-1}	4.3E-07
$t_{1/2\ m}$		s	1.7E+08
	λ_m	s^{-1}	4.2E-09
$t_{d\ a}$		s	2404405
$t_{c\ a}$		s	1292628
$t_{l\ a}$		s	1264268
$t_{d\ m}$		s	3722775
$t_{c\ m}$		s	797
$t_{l\ m}$		s	740
	δ_a	1	1.022
	δ_m	1	1.077
	ξ_a	1	1.00098
	ξ_m	1	1.00319
$n_{p\ a}$		1	4559
$n_{p\ m}$		1	137487
$k_{0\ Au}(a)$		1	0.0007650
$k_{0\ Au}(m)$		1	1.3200
$G_{th\ a}$		1	1

$G_{e\,a}$		1	1
$G_{th\,m}$		1	1
$G_{e\,m}$		1	1
f		1	15.60
α		1	-0.0360
$Q_{0\,a}$		1	14.80
$E_{r\,a}$		eV	839
	$Q_{0\,a}(\alpha)$	1	18.76
$Q_{0\,m}$		1	1.993
$E_{r\,m}$		eV	136.0
	$Q_{0\,m}(\alpha)$	1	2.319
$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$		1	0.9306
COI_m / COI_a		1	0.857
m_m		g	0.00847
m_a		g	0.24000
w_m		g g^{-1}	0.004597
υ		mg L^{-1}	99.2
Y		[Y]	y
ρ_a		g mL^{-1}	8.00E-10

Uncertainty budget of $\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$

Input Quantity	**Quantity**	**Unit**	**Value**
X_i	X_i	$[X_i]$	x_i
a_1		Mev-1	-0.472
a_0		1	-3.229
a_{-1}		Mev	0.403
a_{-2}		Mev2	-0.0320
a_{-3}		Mev3	0.000573
$E_{\gamma\,m}$		MeV	1.17320
$E_{\gamma\,a}$		MeV	1.07700
Δd_a		mm	0
Δd_m		mm	0
	e_4	keV-4	-7.1E-11
	e_3	keV-3	5.2E-08
	e_2	keV-2	-1.4E-05
	e_1	keV-1	1.8E-03
	e_0	1	-4.5E-02
	d_1	keV-1	5.6E-06

	d_0		1	4.2E-02
$\delta\varepsilon_{r\ a}$		mm^{-1}		0.048
$\delta\varepsilon_{r\ m}$		mm^{-1}		0.048
Y		[Y]	y	
$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$		1		0.931

Uncertainty budget of COI_m / COI_a

Input Quantity	**Quantity**	**Unit**	**Value**	
	X_i	**$[X_i]$**	**x_i**	
a_1		Mev-1		-0.472
a_0			1	-3.229
a_{-1}		Mev		0.403
a_{-2}		Mev2		-0.0320
a_{-3}		Mev3		0.000573
	b_1		1	-0.571
	b_0		1	1.079
	c_2		1	-1.625
	c_1		1	6.678
	c_0		1	-7.006
$E_{\gamma 2\ m}$		keV		1332.5
$a_{\gamma 2\ m}$			1	1.000
$c_{\gamma 2\ m}$			1	1.000
$P/T_{\gamma 2\ m}$			1	0.197
	Y	[Y]	y	
	COI_m / COI_a		1	0.857

Net area	Cnts/s	Uncert %	FWHM	source file	start counting
4559	0.004	9.68	1.958	OR50_20171025_CSF_s	10/10/2017
137487	185.919	0.32	1.798	OR50_20170925_Co_sa	10/25/2017

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
17	0.1%	1.7E-16	8.7E-30	0.0%	2.2E+04	8.0E-10
0.0005	1.1%	-4.0E-11	3.9E-28	0.0%	4.5E-02	8.0E-10
1728	0.1%	-1.5E-16	6.3E-26	0.0%	1.6E+06	8.0E-10
4.6E-10	0.1%					
2.6E+04	0.0%	-4.7E-18	1.5E-26	0.0%	1.7E+08	8.0E-10
6.5E-13	0.0%					
35	0.0%	3.4E-16	1.4E-28	0.0%	2.4E+06	8.0E-10
0.3	0.0%	1.8E-16	2.8E-33	0.0%	1.3E+06	8.0E-10
0.3	0.0%	-6.6E-16	3.6E-32	0.0%	1.3E+06	8.0E-10
35	0.0%	-3.3E-18	1.3E-32	0.0%	3.7E+06	8.0E-10
0.3	0.0%	-4.1E-14	1.4E-28	0.0%	8.0E+02	8.0E-10
0.3	0.0%	1.1E-12	1.1E-25	0.0%	7.4E+02	8.0E-10
0.000	0.0%					
0.001	0.1%					
0.00001	0.0%					
0.00004	0.0%					
441	9.7%	1.8E-13	6.0E-21	83.4%	5.0E+03	8.8E-10
440	0.3%	-5.8E-15	6.5E-24	0.1%	1.4E+05	8.0E-10
0.0000077	1.0%	-1.0E-06	6.4E-23	0.9%	7.7E-04	7.9E-10
0.0053	0.4%	6.1E-10	1.0E-23	0.1%	1.3E+00	8.0E-10
0	0.0%	-3.6E-10	0.0E+00	0.0%	1.0E+00	8.0E-10

	0	0.0%	-4.4E-10	0.0E+00	0.0%	1.0E+00	8.0E-10
	0	0.0%	7.0E-10	0.0E+00	0.0%	1.0E+00	8.0E-10
	0	0.0%	1.0E-10	0.0E+00	0.0%	1.0E+00	8.0E-10
	0.33	2.1%	2.1E-11	4.9E-23	0.7%	1.6E+01	8.1E-10
	0.0064	17.8%	2.4E-09	2.5E-22	3.4%	-3.0E-02	8.2E-10
	0.37	2.5%	-3.0E-11	1.2E-22	1.7%	1.5E+01	7.9E-10
	50	6.0%	-1.8E-14	8.5E-25	0.0%	8.9E+02	8.0E-10
	0.92	4.9%					
	0.060	3.0%	5.3E-11	1.0E-23	0.1%	2.1E+00	8.0E-10
	6.9	5.1%	2.2E-14	2.3E-26	0.0%	1.4E+02	8.0E-10
	0.095	4.1%					
	0.0184	2.0%	8.6E-10	2.5E-22	3.5%	9.5E-01	8.2E-10
	0.017	2.0%	9.3E-10	2.5E-22	3.5%	8.7E-01	8.2E-10
	0.00005	0.6%	9.4E-08	2.2E-23	0.3%	8.5E-03	8.0E-10
	0.00005	0.0%	-3.3E-09	2.8E-26	0.0%	2.4E-01	8.0E-10
	0.000046	1.0%	1.7E-07	6.4E-23	0.9%	4.6E-03	8.1E-10
	1.2	1.2%	-8.1E-12	9.4E-23	1.3%	1.0E+02	7.9E-10
$u_c(y)$		$u_{c\,r}(y)$		Σ			
	8.5E-11	10.6%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$\mathbf{u(x_i)}$	$u_r(x_i)$	$\mathbf{c_i}$	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	9.0E-02	1.1E-05	3.3%	-4.3E-01	9.3E-01
0.057	1.8%	0.0E+00	0.0E+00	0.0%	-3.2E+00	9.3E-01
0.020	4.8%	-7.1E-02	-3.2E-06	-0.9%	4.2E-01	9.3E-01
0.0022	6.9%	-1.3E-01	5.7E-07	0.2%	-3.0E-02	9.3E-01
0.000075	13.1%	-1.7E-01	-2.3E-08	0.0%	6.5E-04	9.3E-01
0.00012	0.0%	-6.8E-01	6.1E-09	0.0%	1.2E+00	9.3E-01
0.00012	0.0%	7.2E-01	6.9E-09	0.0%	1.1E+00	9.3E-01
0.29		4.4E-02	1.6E-04	48.2%	2.9E-01	9.4E-01
0.29		-4.5E-02	1.7E-04	49.3%	2.9E-01	9.2E-01
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					

0.0000	0.0%					
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.3E-02	9.3E-01
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.4E-02	9.3E-01

$u_c(y)$	$u_{c\,r}(y)$	Σ
0.018	2.0%	100.0%

Std unc $u(x_i)$	Rel std unc $u_r(x_i)$	**Sensit coeff** c_i	Variance y $u^2_y(x_i)$	**Index**	Input for sensit coeff $x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	-0.1901	1.7E-05	5.9%	-4.3E-01	8.5E-01
0.057	1.8%	-0.1427	-1.4E-05	-4.9%	-3.2E+00	8.5E-01
0.020	4.8%	-0.1070	3.0E-06	1.0%	4.2E-01	8.6E-01
0.0022	6.9%	-0.0803	-2.2E-07	-0.1%	-3.0E-02	8.6E-01
0.000075	13.1%	-0.0603	5.0E-09	0.0%	6.5E-04	8.6E-01
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0.1	0.0%	0.0001	1.2E-10	0.0%	1.3E+03	8.6E-01
0.012	1.2%	-0.1426	2.7E-06	0.9%	1.0E+00	8.6E-01
0.012	1.2%	-0.1426	2.7E-06	0.9%	1.0E+00	8.6E-01
0.023	11.5%	0.7343	2.8E-04	96.2%	2.2E-01	8.7E-01

$u_c(y)$	$u_r(y)$	Σ
0.017	2.0%	100.0%

	t_c / s	t_l / s	$t_{dead\ r}$ / %	t_d / s	t_c / $t_{1/2}$	t_d / $t_{1/2}$
10:39 AM	1292628	1264268	2.2%	2404405	0.80	1.5
4:52 PM	797	740	7.2%	3722775	0.00	0.0

Covariance matrix of ρ_a

x_i-u(x_i)	y(x_i-u(x_i))		t_i	μ	$t_{1/2\ a}$	$t_{1/2\ m}$
2.2E+04	8.0E-10	t_i	1	0	0	0
4.4E-02	8.0E-10	μ	0	1	0	0
1.6E+06	8.0E-10	$t_{1/2\ a}$	0	0	1	0
		$t_{1/2\ m}$	0	0	0	1
1.7E+08	8.0E-10	$t_{d\ a}$	0	0	0	0
		$t_{c\ a}$	0	0	0	0
2.4E+06	8.0E-10	$t_{l\ a}$	0	0	0	0
1.3E+06	8.0E-10	$t_{d\ m}$	0	0	0	0
1.3E+06	8.0E-10	$t_{c\ m}$	0	0	0	0
3.7E+06	8.0E-10	$t_{l\ m}$	0	0	0	0
8.0E+02	8.0E-10	$n_{p\ a}$	0	0	0	0
7.4E+02	8.0E-10	$n_{p\ m}$	0	0	0	0
		$k_{0\ Au}$(a)	0	0	0	0
		$k_{0\ Au}$(m)	0	0	0	0
		$G_{th\ a}$	0	0	0	0
		$G_{e\ a}$	0	0	0	0
4.1E+03	7.2E-10	$G_{th\ m}$	0	0	0	0
1.4E+05	8.0E-10	$G_{e\ m}$	0	0	0	0
7.6E-04	8.1E-10	f	0	0	0	0
1.3E+00	8.0E-10	α	0	0	0	0
1.0E+00	8.0E-10	$Q_{0\ a}$	0	0	0	0

1.0E+00	8.0E-10
1.0E+00	8.0E-10
1.0E+00	8.0E-10
1.5E+01	7.9E-10
-4.2E-02	7.8E-10
1.4E+01	8.1E-10
7.9E+02	8.0E-10
1.9E+00	8.0E-10
1.3E+02	8.0E-10
9.1E-01	7.8E-10
8.4E-01	7.8E-10
8.4E-03	7.9E-10
2.4E-01	8.0E-10
4.6E-03	7.9E-10
9.8E+01	8.1E-10

$E_{r\,a}$	0	0	0	0
$Q_{0\,m}$	0	0	0	0
$E_{r\,m}$	0	0	0	0
$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}$	0	0	0	0
COI_m / COI_a	0	0	0	0
m_m	0	0	0	0
m_a	0	0	0	0
w_m	0	0	0	0
υ	0	0	0	0

Correlation matrix of $\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	9.3E-01
-3.3E+00	9.3E-01
3.8E-01	9.3E-01
-3.4E-02	9.3E-01
5.0E-04	9.3E-01
1.2E+00	9.3E-01
1.1E+00	9.3E-01
-2.9E-01	9.2E-01
-2.9E-01	9.4E-01

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma\,m}$	0	0	0	0
$E_{\gamma\,a}$	0	0	0	0
Δd_a	0	0	0	0
Δd_m	0	0	0	0
$\delta\varepsilon_{r\,a}$	0	0	0	0
$\delta\varepsilon_{r\,m}$	0	0	0	0

4.2E-02	9.3E-01
4.3E-02	9.3E-01

Correlation matrix of COI_m / COI_a

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	8.7E-01
-3.3E+00	8.7E-01
3.8E-01	8.6E-01
-3.4E-02	8.6E-01
5.0E-04	8.6E-01

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma 2\ m}$	0	0	0	0
$a_{\gamma 2\ m}$	0	0	0	0
$c_{\gamma 2\ m}$	0	0	0	0
$P/T_{\gamma 2\ m}$	0	0	0	0

1.3E+03	8.6E-01
9.9E-01	8.6E-01
9.9E-01	8.6E-01
1.7E-01	8.4E-01

$t_{d\,a}$	$t_{c\,a}$	$t_{l\,a}$	$t_{d\,m}$	$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

a_{-3}	$E_{\gamma m}$	$E_{\gamma a}$	Δd_a	Δd_m	$\delta\varepsilon_{r a}$	$\delta\varepsilon_{r m}$	c_i
0.748	0	0	0	0	0	0	9.0E-02
-0.848	0	0	0	0	0	0	0.0E+00
0.957	0	0	0	0	0	0	-7.1E-02
-0.993	0	0	0	0	0	0	-1.3E-01
1.000	0	0	0	0	0	0	-1.7E-01
0	1	0	0	0	0	0	-6.8E-01
0	0	1	0	0	0	0	7.2E-01
0	0	0	1	0	0	0	4.4E-02
0	0	0	0	1	0	0	-4.5E-02
0	0	0	0	0	1	1	0.0E+00
0	0	0	0	0	1	1	0.0E+00

Covariance

a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	c_i	
0.748	0	0	0	0	-1.9E-01	a_1
-0.848	0	0	0	0	-1.4E-01	a_0
0.957	0	0	0	0	-1.1E-01	a_{-1}
-0.993	0	0	0	0	-8.0E-02	a_{-2}
1.000	0	0	0	0	-6.0E-02	a_{-3}
0	1	0	0	0	9.6E-05	$E_{\gamma 2\ m}$
0	0	1	0	0	-1.4E-01	$a_{\gamma 2\ m}$
0	0	0	1	0	-1.4E-01	$c_{\gamma 2\ m}$
0	0	0	0	1	7.3E-01	$P/T_{\gamma 2\ m}$

c_i

$k_{0\ Au}(m)$	$G_{th\ a}$	$G_{e\ a}$	$G_{th\ m}$	$G_{e\ m}$	f	α	$Q_{0\ a}$	$E_{r\ a}$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0

0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Covariance matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

	a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma\,m}$	$E_{\gamma\,a}$
a_1	1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00
a_0	-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00
a_{-1}	7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00
a_{-3}	2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00
$E_{\gamma\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08	0.0E+00
$E_{\gamma\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08
Δd_a	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Δd_m	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
c_i	9.0E-02	0.0E+00	-7.1E-02	-1.3E-01	-1.7E-01	-6.8E-01	7.2E-01

matrix of COI_m/COI_a

a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$
1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-04
-1.9E-01	-1.4E-01	-1.1E-01	-8.0E-02	-6.0E-02	9.6E-05	-1.4E-01	-1.4E-01	7.3E-01

$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	COI_m / COI_a	m_m	m_a	w_m
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

0	0	0	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	1	0	0	0	0
0	0	0	1	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	1	0
0	0	0	0	0	0	1
0	0	0	0	0	0	0

Δd_a	Δd_m	$\delta\varepsilon_{r\ a}$	$\delta\varepsilon_{r\ m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	3.0E-05	3.1E-05
0.0E+00	0.0E+00	3.1E-05	3.1E-05
4.4E-02	-4.5E-02	0.0E+00	0.0E+00

Covariance matrix of ρ_a

υ	c_i		t_i	μ
0	1.7E-16	t_i	3.0E+02	0.0E+00
0	-4.0E-11	μ	0.0E+00	2.5E-07
0	-1.5E-16	$t_{1/2\ a}$	0.0E+00	0.0E+00
0	-4.7E-18	$t_{1/2\ m}$	0.0E+00	0.0E+00
0	3.4E-16	$t_{d\ a}$	0.0E+00	0.0E+00
0	1.8E-16	$t_{c\ a}$	0.0E+00	0.0E+00
0	-6.6E-16	$t_{l\ a}$	0.0E+00	0.0E+00
0	-3.3E-18	$t_{d\ m}$	0.0E+00	0.0E+00
0	-4.1E-14	$t_{c\ m}$	0.0E+00	0.0E+00
0	1.1E-12	$t_{l\ m}$	0.0E+00	0.0E+00
0	1.8E-13	$n_{p\ a}$	0.0E+00	0.0E+00
0	-5.8E-15	$n_{p\ m}$	0.0E+00	0.0E+00
0	-1.0E-06	$k_{0\ Au}(a)$	0.0E+00	0.0E+00
0	6.1E-10	$k_{0\ Au}(m)$	0.0E+00	0.0E+00
0	-3.6E-10	$G_{th\ a}$	0.0E+00	0.0E+00
0	-4.4E-10	$G_{e\ a}$	0.0E+00	0.0E+00
0	7.0E-10	$G_{th\ m}$	0.0E+00	0.0E+00
0	1.0E-10	$G_{e\ m}$	0.0E+00	0.0E+00
0	2.1E-11	f	0.0E+00	0.0E+00
0	2.4E-09	α	0.0E+00	0.0E+00
0	-3.0E-11	$Q_{0\ a}$	0.0E+00	0.0E+00

0	-1.8E-14	$E_{r\ a}$	0.0E+00	0.0E+00
0	5.3E-11	$Q_{0\ m}$	0.0E+00	0.0E+00
0	2.2E-14	$E_{r\ m}$	0.0E+00	0.0E+00
0	8.6E-10	$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$	0.0E+00	0.0E+00
0	9.3E-10	COI_m / COI_a	0.0E+00	0.0E+00
0	9.4E-08	m_m	0.0E+00	0.0E+00
0	-3.3E-09	m_a	0.0E+00	0.0E+00
0	1.7E-07	w_m	0.0E+00	0.0E+00
1	-8.1E-12	υ	0.0E+00	0.0E+00
		$\mathbf{c}_i$	1.7E-16	-4.0E-11

$t_{1/2\ a}$	$t_{1/2\ m}$	$t_{d\ a}$	$t_{c\ a}$	$t_{l\ a}$	$t_{d\ m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
3.0E+06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	6.7E+08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.2E+03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E+03
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.5E-16	-4.7E-18	3.4E-16	1.8E-16	-6.6E-16	-3.3E-18

$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$	$k_{0\,Au}(m)$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.9E+05	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.9E+05	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.9E-11	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.8E-05
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-4.1E-14	1.1E-12	1.8E-13	-5.8E-15	-1.0E-06	6.1E-10

$G_{th\ a}$	$G_{e\ a}$	$G_{th\ m}$	$G_{e\ m}$	f
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E-01
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-3.6E-10	-4.4E-10	7.0E-10	1.0E-10	2.1E-11

α	$Q_{0\,a}$	$E_{r\,a}$	$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	1.4E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	2.5E+03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	3.6E-03	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.8E+01	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.4E-04
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.4E-09	-3.0E-11	-1.8E-14	5.3E-11	2.2E-14	8.6E-10

COI_m / COI_a	m_m	m_a	w_m	υ
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.9E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	2.5E-09	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.5E-09	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	2.1E-09	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.4E+00
9.3E-10	9.4E-08	-3.3E-09	1.7E-07	-8.1E-12

Irradiation and γ-spectrometry

end irradiation		9/12/2017	2.46 PM
irradiation time / s		21600	

library	CSF.Lib
calib	OR50_source2016_geom_cont_12052017.Clb
sm type	CSF.Lib (ROI32 Analysis)

Nuclide	Channel	Energy	Background
59Fe	4396.05	1099.3	47748
Co60	4691.96	1173.2	5220

	target	product
analite, a	^{58}Fe	^{59}Fe
monitor, m	^{59}Co	^{60}Co

Uncertainty budget of ρ_a

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
t_i		s	21600
μ		1	0.0445
$t_{1/2\ a}$		s	3844800
	λ_a	s^{-1}	1.8E-07
$t_{1/2\ m}$		s	1.7E+08
	λ_m	s^{-1}	4.2E-09
$t_{d\ a}$		s	2404405
$t_{c\ a}$		s	1292628
$t_{l\ a}$		s	1264268
$t_{d\ m}$		s	3722775
$t_{c\ m}$		s	797
$t_{l\ m}$		s	740
	δ_a	1	1.022
	δ_m	1	1.077
	ξ_a	1	1.00098
	ξ_m	1	1.00319
$n_{p\ a}$		1	9456
$n_{p\ m}$		1	137487
$k_{0\ Au}(a)$		1	0.00007770
$k_{0\ Au}(m)$		1	1.3200
$G_{th\ a}$		1	1

$G_{e\ a}$		1	1
$G_{th\ m}$		1	1
$G_{e\ m}$		1	1
f		1	15.60
α		1	-0.0360
$Q_{0\ a}$		1	0.975
$E_{r\ a}$		eV	637
	$Q_{0\ a}(\alpha)$	1	1.14
$Q_{0\ m}$		1	1.993
$E_{r\ m}$		eV	136.0
	$Q_{0\ m}(\alpha)$	1	2.319
$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$		1	0.9466
COI_m / COI_a		1	0.868
m_m		g	0.00847
m_a		g	0.24000
w_m		$g\ g^{-1}$	0.004597
υ		$mg\ L^{-1}$	99.2
Y		[Y]	y
ρ_a		$g\ mL^{-1}$	3.87E-08

Uncertainty budget of $\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$

Input Quantity X_i	Quantity X_i	Unit $[X_i]$		Value x_i
a_1		Mev-1		-0.472
a_0			1	-3.229
a_{-1}		Mev		0.403
a_{-2}		Mev2		-0.0320
a_{-3}		Mev3		0.000573
$E_{\gamma\ m}$		MeV		1.17320
$E_{\gamma\ a}$		MeV		1.09930
Δd_a		mm		0
Δd_m		mm		0
	e_4	keV-4		-7.1E-11
	e_3	keV-3		5.2E-08
	e_2	keV-2		-1.4E-05
	e_1	keV-1		1.8E-03
	e_0		1	-4.5E-02
	d_1	keV-1		5.6E-06

	d_0		1	4.2E-02
$\delta\varepsilon_{r\,a}$		mm^{-1}		0.048
$\delta\varepsilon_{r\,m}$		mm^{-1}		0.048
Y		[Y]	y	
$\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$		1		0.947

Uncertainty budget of COI_m / COI_a

Input Quantity	Quantity X_i	Unit $[X_i]$	Value x_i	
a_1		Mev-1		-0.472
a_0			1	-3.229
a_{-1}		Mev		0.403
a_{-2}		Mev2		-0.0320
a_{-3}		Mev3		0.000573
	b_1		1	-0.571
	b_0		1	1.079
	c_2		1	-1.625
	c_1		1	6.678
	c_0		1	-7.006
$E_{\gamma 2\,m}$		keV		1332.5
$a_{\gamma 2\,m}$			1	1.000
$c_{\gamma 2\,m}$			1	1.000
$P/T_{\gamma 2\,m}$			1	0.197
$E_{\gamma 4\,a}$		keV		192.3
$P_{\gamma 4\,a}$			1	2.95%
$P/T_{\gamma 4\,a}$			1	0.595
$a_{\gamma 5\,a}$			1	1.000
$c_{\gamma 5\,a}$			1	1.000
$P_{\gamma 5\,a}$			1	56.1%
	Y	[Y]	y	
	COI_m / COI_a		1	0.868

Net area	Cnts/s	Uncert %	FWHM	source file	start counting
9456	0.007	6.2	1.895	OR50_20171025_CSF_s	10/10/2017
137487	185.919	0.32	1.798	OR50_20170925_Co_sa	10/25/2017

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
17	0.1%	3.4E-15	3.5E-27	0.0%	2.2E+04	3.9E-08
0.0005	1.1%	-1.9E-09	9.2E-25	0.0%	4.5E-02	3.9E-08
518	0.0%	4.6E-15	5.6E-24	0.0%	3.8E+06	3.9E-08
2.4E-11	0.0%					
2.6E+04	0.0%	-2.3E-16	3.5E-23	0.0%	1.7E+08	3.9E-08
6.5E-13	0.0%					
35	0.0%	7.0E-15	5.8E-26	0.0%	2.4E+06	3.9E-08
0.3	0.0%	4.7E-15	1.8E-30	0.0%	1.3E+06	3.9E-08
0.3	0.0%	-3.2E-14	8.5E-29	0.0%	1.3E+06	3.9E-08
35	0.0%	-1.6E-16	3.1E-29	0.0%	3.7E+06	3.9E-08
0.3	0.0%	-2.0E-12	3.4E-25	0.0%	8.0E+02	3.9E-08
0.3	0.0%	5.4E-11	2.5E-22	0.0%	7.4E+02	3.9E-08
0.000	0.0%					
0.001	0.1%					
0.00001	0.0%					
0.00004	0.0%					
586	6.2%	4.1E-12	5.8E-18	78.0%	1.0E+04	4.1E-08
440	0.3%	-2.8E-13	1.5E-20	0.2%	1.4E+05	3.9E-08
0.00000039	0.5%	-5.0E-04	3.7E-20	0.5%	7.8E-05	3.9E-08
0.0053	0.4%	2.9E-08	2.4E-20	0.3%	1.3E+00	3.9E-08
0	0.0%	-3.6E-08	0.0E+00	0.0%	1.0E+00	3.9E-08

0	0.0%	-2.6E-09	0.0E+00	0.0%	1.0E+00	3.9E-08
0	0.0%	3.4E-08	0.0E+00	0.0%	1.0E+00	3.9E-08
0	0.0%	5.0E-09	0.0E+00	0.0%	1.0E+00	3.9E-08
0.33	2.1%	-1.5E-10	2.5E-21	0.0%	1.6E+01	3.9E-08
0.0064	17.8%	-9.4E-09	3.6E-21	0.0%	-3.0E-02	3.9E-08
0.010	1.0%	-2.9E-09	8.1E-22	0.0%	9.8E-01	3.9E-08
153	24.0%	-9.2E-14	2.0E-22	0.0%	7.9E+02	3.9E-08
0.04	3.1%					
0.060	3.0%	2.6E-09	2.4E-20	0.3%	2.1E+00	3.9E-08
6.9	5.1%	1.1E-12	5.5E-23	0.0%	1.4E+02	3.9E-08
0.095	4.1%					
0.0187	2.0%	4.1E-08	5.8E-19	7.9%	9.7E-01	3.9E-08
0.016	1.8%	4.5E-08	5.1E-19	6.9%	8.8E-01	3.9E-08
0.00005	0.6%	4.6E-06	5.2E-20	0.7%	8.5E-03	3.9E-08
0.00005	0.0%	-1.6E-07	6.5E-23	0.0%	2.4E-01	3.9E-08
0.000046	1.0%	8.4E-06	1.5E-19	2.0%	4.6E-03	3.9E-08
1.2	1.2%	-3.9E-10	2.2E-19	3.0%	1.0E+02	3.8E-08
$u_c(y)$	$u_{c\,r}(y)$			Σ		
2.7E-09	7.0%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	7.0E-02	6.9E-06	2.0%	-4.3E-01	9.5E-01
0.057	1.8%	0.0E+00	0.0E+00	0.0%	-3.2E+00	9.5E-01
0.020	4.8%	-5.4E-02	-1.9E-06	-0.6%	4.2E-01	9.5E-01
0.0022	6.9%	-9.6E-02	3.4E-07	0.1%	-3.0E-02	9.5E-01
0.000075	13.1%	-1.3E-01	-1.4E-08	0.0%	6.5E-04	9.5E-01
0.00012	0.0%	-6.9E-01	6.3E-09	0.0%	1.2E+00	9.5E-01
0.00012	0.0%	7.2E-01	6.9E-09	0.0%	1.1E+00	9.5E-01
0.29		4.5E-02	1.7E-04	48.8%	2.9E-01	9.6E-01
0.29		-4.6E-02	1.7E-04	49.7%	2.9E-01	9.3E-01
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					

0.0000	0.0%					
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.3E-02	9.5E-01
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.4E-02	9.5E-01
$u_c(y)$	$u_{c\,r}(y)$			Σ		
0.019	2.0%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$\mathbf{u(x_i)}$	$u_r(x_i)$	$\mathbf{c_i}$	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	-0.1904	1.7E-05	6.6%	-4.3E-01	8.6E-01
0.057	1.8%	-0.1339	-1.3E-05	-5.2%	-3.2E+00	8.6E-01
0.020	4.8%	-0.0539	1.5E-06	0.6%	4.2E-01	8.7E-01
0.0022	6.9%	0.2016	5.3E-07	0.2%	-3.0E-02	8.7E-01
0.000075	13.1%	1.4091	-1.1E-07	0.0%	6.5E-04	8.7E-01
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0.1	0.0%	0.0001	1.3E-10	0.0%	1.3E+03	8.7E-01
0.012	1.2%	-0.1443	2.8E-06	1.1%	1.0E+00	8.7E-01
0.012	1.2%	-0.1443	2.8E-06	1.1%	1.0E+00	8.7E-01
0.023	11.5%	0.7431	2.6E-04	103.1%	2.2E-01	8.8E-01
0.12	0.1%	0.0000	1.9E-11	0.0%	1.9E+02	8.7E-01
0.01%	0.4%	0.3544	1.7E-09	0.0%	3.0E-02	8.7E-01
0.069	11.5%	-0.0178	-1.9E-05	-7.5%	6.6E-01	8.7E-01
0.012	1.2%	0.0105	1.5E-08	0.0%	1.0E+00	8.7E-01
0.012	1.2%	0.0105	1.5E-08	0.0%	1.0E+00	8.7E-01
0.12%	0.2%	-0.0186	4.6E-10	0.0%	5.6E-01	8.7E-01
$u_c(y)$	$u_r(y)$			Σ		
0.016	1.8%			100.0%		

	t_c / s	t_l / s	$t_{dead\ r}$ / %	t_d / s	t_c / $t_{1/2}$	t_d / $t_{1/2}$
10:39 AM	1292628	1264268	2.2%	2404405	0.34	0.6
4:52 PM	797	740	7.2%	3722775	0.00	0.0

Correlation matrix of ρ_a

x_i-u(x_i)	y(x_i-u(x_i))		t_i	μ	$t_{1/2\ a}$	$t_{1/2\ m}$
2.2E+04	3.9E-08	t_i	1	0	0	0
4.4E-02	3.9E-08	μ	0	1	0	0
3.8E+06	3.9E-08	$t_{1/2\ a}$	0	0	1	0
		$t_{1/2\ m}$	0	0	0	1
1.7E+08	3.9E-08	$t_{d\ a}$	0	0	0	0
		$t_{c\ a}$	0	0	0	0
2.4E+06	3.9E-08	$t_{l\ a}$	0	0	0	0
1.3E+06	3.9E-08	$t_{d\ m}$	0	0	0	0
1.3E+06	3.9E-08	$t_{c\ m}$	0	0	0	0
3.7E+06	3.9E-08	$t_{l\ m}$	0	0	0	0
8.0E+02	3.9E-08	$n_{p\ a}$	0	0	0	0
7.4E+02	3.9E-08	$n_{p\ m}$	0	0	0	0
		$k_{0\ Au}$(a)	0	0	0	0
		$k_{0\ Au}$(m)	0	0	0	0
		$G_{th\ a}$	0	0	0	0
		$G_{e\ a}$	0	0	0	0
8.9E+03	3.6E-08	$G_{th\ m}$	0	0	0	0
1.4E+05	3.9E-08	$G_{e\ m}$	0	0	0	0
7.7E-05	3.9E-08	f	0	0	0	0
1.3E+00	3.9E-08	α	0	0	0	0
1.0E+00	3.9E-08	$Q_{0\ a}$	0	0	0	0

1.0E+00	3.9E-08
1.0E+00	3.9E-08
1.0E+00	3.9E-08
1.5E+01	3.9E-08
-4.2E-02	3.9E-08
9.7E-01	3.9E-08
4.8E+02	3.9E-08
1.9E+00	3.9E-08
1.3E+02	3.9E-08
9.3E-01	3.8E-08
8.5E-01	3.8E-08
8.4E-03	3.8E-08
2.4E-01	3.9E-08
4.6E-03	3.8E-08
9.8E+01	3.9E-08

$E_{r\,a}$	0	0	0	0
$Q_{0\,m}$	0	0	0	0
$E_{r\,m}$	0	0	0	0
$\varepsilon_{p\,m}{}^{geo}$ / $\varepsilon_{p\,a}$	0	0	0	0
COI_m / COI_a	0	0	0	0
m_m	0	0	0	0
m_a	0	0	0	0
w_m	0	0	0	0
υ	0	0	0	0

Correlation matrix of $\varepsilon_{p\,m}{}^{geo}$ / $\varepsilon_{p\,a}{}^{geo}$

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	9.4E-01
-3.3E+00	9.5E-01
3.8E-01	9.5E-01
-3.4E-02	9.5E-01
5.0E-04	9.5E-01
1.2E+00	9.5E-01
1.1E+00	9.5E-01
-2.9E-01	9.3E-01
-2.9E-01	9.6E-01

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma\,m}$	0	0	0	0
$E_{\gamma\,a}$	0	0	0	0
Δd_a	0	0	0	0
Δd_m	0	0	0	0
$\delta\varepsilon_{r\,a}$	0	0	0	0
$\delta\varepsilon_{r\,m}$	0	0	0	0

4.2E-02	9.5E-01
4.3E-02	9.5E-01

Correlation matrix of COI_m / COI_a

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	8.8E-01
-3.3E+00	8.8E-01
3.8E-01	8.7E-01
-3.4E-02	8.7E-01
5.0E-04	8.7E-01
1.3E+03	8.7E-01
9.9E-01	8.7E-01
9.9E-01	8.7E-01
1.7E-01	8.5E-01
1.9E+02	8.7E-01
2.9E-02	8.7E-01
5.3E-01	8.7E-01
9.9E-01	8.7E-01
9.9E-01	8.7E-01
5.6E-01	8.7E-01

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma 2\ m}$	0	0	0	0
$a_{\gamma 2\ m}$	0	0	0	0
$c_{\gamma 2\ m}$	0	0	0	0
$P/T_{\gamma 2\ m}$	0	0	0	0
$E_{\gamma 4\ a}$	0	0	0	0
$P_{\gamma 4\ a}$	0	0	0	0
$P/T_{\gamma 4\ a}$	0	0	0	0
$a_{\gamma 5\ a}$	0	0	0	0
$c_{\gamma 5\ a}$	0	0	0	0
$P_{\gamma 5\ a}$	0	0	0	0

$t_{d\,a}$	$t_{c\,a}$	$t_{l\,a}$	$t_{d\,m}$	$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

a_{-3}	$E_{\gamma m}$	$E_{\gamma a}$	Δd_a	Δd_m	$\delta\varepsilon_{r a}$	$\delta\varepsilon_{r m}$		c_i
0.748	0	0	0	0	0	0		7.0E-02
-0.848	0	0	0	0	0	0		0.0E+00
0.957	0	0	0	0	0	0		-5.4E-02
-0.993	0	0	0	0	0	0		-9.6E-02
1.000	0	0	0	0	0	0		-1.3E-01
0	1	0	0	0	0	0		-6.9E-01
0	0	1	0	0	0	0		7.2E-01
0	0	0	1	0	0	0		4.5E-02
0	0	0	0	1	0	0		-4.6E-02
0	0	0	0	0	1	1		0.0E+00
0	0	0	0	0	1	1		0.0E+00

a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	$E_{\gamma 4\ a}$	$P_{\gamma 4\ a}$	$P/T_{\gamma 4\ a}$	$a_{\gamma 5\ a}$
0.748	0	0	0	0	0	0	0	0
-0.848	0	0	0	0	0	0	0	0
0.957	0	0	0	0	0	0	0	0
-0.993	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	1	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	1	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

$k_{0\,Au}$(m)	$G_{th\,a}$	$G_{e\,a}$	$G_{th\,m}$	$G_{e\,m}$	f	α	$Q_{0\,a}$	$E_{r\,a}$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0

0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Covariance matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

	a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma\,m}$	$E_{\gamma\,a}$
a_1	1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00
a_0	-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00
a_{-1}	7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00
a_{-3}	2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00
$E_{\gamma\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08	0.0E+00
$E_{\gamma\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08
Δd_a	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Δd_m	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
c_i	7.0E-02	0.0E+00	-5.4E-02	-9.6E-02	-1.3E-01	-6.9E-01	7.2E-01

$c_{\gamma 5\ a}$	$P_{\gamma 5\ a}$	c_i
0	0	-1.9E-01
0	0	-1.3E-01
0	0	-5.4E-02
0	0	2.0E-01
0	0	1.4E+00
0	0	9.7E-05
0	0	-1.4E-01
0	0	-1.4E-01
0	0	7.4E-01
0	0	-3.8E-05
0	0	3.5E-01
0	0	-1.8E-02
0	0	1.0E-02
1	0	1.0E-02
0	1	-1.9E-02

Covariance matrix of COI_m/COI_a

	a_1	a_0	a_{-1}
a_1	1.9E-03	-2.4E-03	7.5E-04
a_0	-2.4E-03	3.2E-03	-1.1E-03
a_{-1}	7.5E-04	-1.1E-03	3.8E-04
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05
a_{-3}	2.4E-06	-3.6E-06	1.4E-06
$E_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$a_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$c_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$P/T_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
$E_{\gamma 4\ a}$	0.0E+00	0.0E+00	0.0E+00
$P_{\gamma 4\ a}$	0.0E+00	0.0E+00	0.0E+00
$P/T_{\gamma 4\ a}$	0.0E+00	0.0E+00	0.0E+00
$a_{\gamma 5\ a}$	0.0E+00	0.0E+00	0.0E+00
$c_{\gamma 5\ a}$	0.0E+00	0.0E+00	0.0E+00
$P_{\gamma 5\ a}$	0.0E+00	0.0E+00	0.0E+00
c_i	-1.9E-01	-1.3E-01	-5.4E-02

$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	COI_m / COI_a	m_m	m_a	w_m
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

0	0	0	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	1	0	0	0	0
0	0	0	1	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	1	0
0	0	0	0	0	0	1
0	0	0	0	0	0	0

Δd_a	Δd_m	$\delta \varepsilon_{r\,a}$	$\delta \varepsilon_{r\,m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	3.0E-05	3.1E-05
0.0E+00	0.0E+00	3.1E-05	3.1E-05
4.5E-02	-4.6E-02	0.0E+00	0.0E+00

a_{-2}	a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	$E_{\gamma 4\ a}$
-7.7E-05	2.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.1E-04	-3.6E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-4.3E-05	1.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.9E-06	-1.7E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.7E-07	5.7E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-02
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.6E-03	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.0E-01	1.4E+00	9.7E-05	-1.4E-01	-1.4E-01	7.4E-01	-3.8E-05

Covariance matrix of ρ_a

υ	c_i		t_i	μ
0	3.4E-15	t_i	3.0E+02	0.0E+00
0	-1.9E-09	μ	0.0E+00	2.5E-07
0	4.6E-15	$t_{1/2\ a}$	0.0E+00	0.0E+00
0	-2.3E-16	$t_{1/2\ m}$	0.0E+00	0.0E+00
0	7.0E-15	$t_{d\ a}$	0.0E+00	0.0E+00
0	4.7E-15	$t_{c\ a}$	0.0E+00	0.0E+00
0	-3.2E-14	$t_{l\ a}$	0.0E+00	0.0E+00
0	-1.6E-16	$t_{d\ m}$	0.0E+00	0.0E+00
0	-2.0E-12	$t_{c\ m}$	0.0E+00	0.0E+00
0	5.4E-11	$t_{l\ m}$	0.0E+00	0.0E+00
0	4.1E-12	$n_{p\ a}$	0.0E+00	0.0E+00
0	-2.8E-13	$n_{p\ m}$	0.0E+00	0.0E+00
0	-5.0E-04	$k_{0\ Au}(a)$	0.0E+00	0.0E+00
0	2.9E-08	$k_{0\ Au}(m)$	0.0E+00	0.0E+00
0	-3.6E-08	$G_{th\ a}$	0.0E+00	0.0E+00
0	-2.6E-09	$G_{e\ a}$	0.0E+00	0.0E+00
0	3.4E-08	$G_{th\ m}$	0.0E+00	0.0E+00
0	5.0E-09	$G_{e\ m}$	0.0E+00	0.0E+00
0	-1.5E-10	f	0.0E+00	0.0E+00
0	-9.4E-09	α	0.0E+00	0.0E+00
0	-2.9E-09	$Q_{0\ a}$	0.0E+00	0.0E+00

0	-9.2E-14	$E_{r\,a}$	0.0E+00	0.0E+00
0	2.6E-09	$Q_{0\,m}$	0.0E+00	0.0E+00
0	1.1E-12	$E_{r\,m}$	0.0E+00	0.0E+00
0	4.1E-08	$\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$	0.0E+00	0.0E+00
0	4.5E-08	COI_m / COI_a	0.0E+00	0.0E+00
0	4.6E-06	m_m	0.0E+00	0.0E+00
0	-1.6E-07	m_a	0.0E+00	0.0E+00
0	8.4E-06	w_m	0.0E+00	0.0E+00
1	-3.9E-10	υ	0.0E+00	0.0E+00
		$\mathbf{c}_i$	3.4E-15	-1.9E-09

$P_{\gamma 4\ a}$	$P/T_{\gamma 4\ a}$	$a_{\gamma 5\ a}$	$c_{\gamma 5\ a}$	$P_{\gamma 5\ a}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	1.6E-03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.3E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	4.7E-03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-06
3.5E-01	-1.8E-02	1.0E-02	1.0E-02	-1.9E-02

$t_{1/2\ a}$	$t_{1/2\ m}$	$t_{d\ a}$	$t_{c\ a}$	$t_{l\ a}$	$t_{d\ m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.7E+05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	6.7E+08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.2E+03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E+03
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.6E-15	-2.3E-16	7.0E-15	4.7E-15	-3.2E-14	-1.6E-16

$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}$(a)	$k_{0\,Au}$(m)
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	3.4E+05	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.9E+05	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.5E-13	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.8E-05
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.0E-12	5.4E-11	4.1E-12	-2.8E-13	-5.0E-04	2.9E-08

$G_{th\ a}$	$G_{e\ a}$	$G_{th\ m}$	$G_{e\ m}$	f
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E-01
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-3.6E-08	-2.6E-09	3.4E-08	5.0E-09	-1.5E-10

α	$Q_{0\,a}$	$E_{r\,a}$	$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	4.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	9.5E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	2.3E+04	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	3.6E-03	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.8E+01	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.5E-04
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-9.4E-09	-2.9E-09	-9.2E-14	2.6E-09	1.1E-12	4.1E-08

COI_m / COI_a	m_m	m_a	w_m	υ
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.6E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	2.5E-09	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.5E-09	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	2.1E-09	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.4E+00
4.5E-08	4.6E-06	-1.6E-07	8.4E-06	-3.9E-10

Irradiation and γ-spectrometry

end irradiation		9/12/2017	2.46 PM
irradiation time / s		21600	

library	CSF.Lib
calib	OR50_source2016_geom_cont_12052017.Clb
sm type	CSF.Lib (ROI32 Analysis)

Nuclide	Channel	Energy	Background
65Zn	4460.76	1115.5	44801
Co60	4691.96	1173.2	5220

	target	product
analite, a	^{64}Zn	^{65}Zn
monitor, m	^{59}Co	^{60}Co

Uncertainty budget of ρ_a

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
t_i		s	21600
μ		1	0.0445
$t_{1/2\ a}$		s	21107520
	λ_a	s^{-1}	3.3E-08
$t_{1/2\ m}$		s	1.7E+08
	λ_m	s^{-1}	4.2E-09
$t_{d\ a}$		s	2404405
$t_{c\ a}$		s	1292628
$t_{l\ a}$		s	1264268
$t_{d\ m}$		s	3722775
$t_{c\ m}$		s	797
$t_{l\ m}$		s	740
	δ_a	1	1.022
	δ_m	1	1.077
	ξ_a	1	1.00098
	ξ_m	1	1.00319
$n_{p\ a}$		1	122602
$n_{p\ m}$		1	137487
$k_{0\ Au}(a)$		1	0.005720
$k_{0\ Au}(m)$		1	1.3200
$G_{th\ a}$		1	1

$G_{e\,a}$		1	1
$G_{th\,m}$		1	1
$G_{e\,m}$		1	1
f		1	15.60
α		1	-0.0360
$Q_{0\,a}$		1	1.91
$E_{r\,a}$		eV	2560
	$Q_{0\,a}(\alpha)$	1	2.41
$Q_{0\,m}$		1	1.993
$E_{r\,m}$		eV	136.0
	$Q_{0\,m}(\alpha)$	1	2.319
$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$		1	0.9583
COI_m / COI_a		1	0.857
m_m		g	0.00847
m_a		g	0.24000
w_m		$g\,g^{-1}$	0.004597
υ		$mg\,L^{-1}$	99.2
Y		[Y]	y
ρ_a		$g\,mL^{-1}$	2.220E-08

Uncertainty budget of $\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
a_1		Mev-1	-0.472
a_0		1	-3.229
a_{-1}		Mev	0.403
a_{-2}		Mev2	-0.0320
a_{-3}		Mev3	0.000573
$E_{\gamma\,m}$		MeV	1.17320
$E_{\gamma\,a}$		MeV	1.11550
Δd_a		mm	0
Δd_m		mm	0
	e_4	keV-4	-7.1E-11
	e_3	keV-3	5.2E-08
	e_2	keV-2	-1.4E-05
	e_1	keV-1	1.8E-03
	e_0	1	-4.5E-02
	d_1	keV-1	5.6E-06

	d_0		1	4.2E-02
$\delta\varepsilon_{r\,a}$		mm^{-1}		0.048
$\delta\varepsilon_{r\,m}$		mm^{-1}		0.048
Y		[Y]	y	
$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$		1		0.958

Uncertainty budget of COI_m / COI_a

Input Quantity	**Quantity**	**Unit**	**Value**	
	$\mathbf{X_i}$	$\mathbf{[X_i]}$	$\mathbf{x_i}$	
a_1		Mev-1		-0.472
a_0			1	-3.229
a_{-1}		Mev		0.403
a_{-2}		Mev2		-0.0320
a_{-3}		Mev3		0.000573
	b_1		1	-0.571
	b_0		1	1.079
	c_2		1	-1.625
	c_1		1	6.678
	c_0		1	-7.006
$E_{\gamma 2\,m}$		keV		1332.5
$a_{\gamma 2\,m}$			1	1.000
$c_{\gamma 2\,m}$			1	1.000
$P/T_{\gamma 2\,m}$			1	0.197
	Y	[Y]	y	
	COI_m / COI_a		1	0.857

Net area	Cnts/s	Uncert %	FWHM	source file	start counting
122602	0.097	0.38	1.771	OR50_20171025_CSF_s	10/10/2017
137487	185.919	0.32	1.798	OR50_20170925_Co_sa	10/25/2017

Std unc $u(x_i)$	Rel std unc $u_r(x_i)$	**Sensit coeff** c_i	Variance y $u^2_y(x_i)$	**Index**	Input for sensit coeff $x_i+u(x_i)$	$y(x_i+u(x_i))$
17	0.1%	3.2E-16	3.0E-29	0.0%	2.2E+04	2.2E-08
0.0005	1.1%	-1.1E-09	3.0E-25	0.0%	4.5E-02	2.2E-08
8640	0.0%	9.5E-16	6.7E-23	0.0%	2.1E+07	2.2E-08
1.3E-11	0.0%					
2.6E+04	0.0%	-1.3E-16	1.2E-23	0.0%	1.7E+08	2.2E-08
6.5E-13	0.0%					
35	0.0%	7.3E-16	6.4E-28	0.0%	2.4E+06	2.2E-08
0.3	0.0%	1.1E-15	1.0E-31	0.0%	1.3E+06	2.2E-08
0.3	0.0%	-1.8E-14	2.8E-29	0.0%	1.3E+06	2.2E-08
35	0.0%	-9.2E-17	1.0E-29	0.0%	3.7E+06	2.2E-08
0.3	0.0%	-1.2E-12	1.1E-25	0.0%	8.0E+02	2.2E-08
0.3	0.0%	3.1E-11	8.1E-23	0.0%	7.4E+02	2.2E-08
0.000	0.0%					
0.001	0.1%					
0.00001	0.0%					
0.00004	0.0%					
466	0.4%	1.8E-13	7.1E-21	1.2%	1.2E+05	2.2E-08
440	0.3%	-1.6E-13	5.0E-21	0.9%	1.4E+05	2.2E-08
0.000023	0.4%	-3.9E-06	7.9E-21	1.3%	5.7E-03	2.2E-08
0.0053	0.4%	1.7E-08	7.9E-21	1.3%	1.3E+00	2.2E-08
0	0.0%	-1.9E-08	0.0E+00	0.0%	1.0E+00	2.2E-08

0	0.0%	-3.0E-09	0.0E+00	0.0%	1.0E+00	2.2E-08
0	0.0%	1.9E-08	0.0E+00	0.0%	1.0E+00	2.2E-08
0	0.0%	2.9E-09	0.0E+00	0.0%	1.0E+00	2.2E-08
0.33	2.1%	6.6E-12	4.6E-24	0.0%	1.6E+01	2.2E-08
0.0064	17.8%	7.6E-09	2.4E-21	0.4%	-3.0E-02	2.2E-08
0.10	5.0%	-1.6E-09	2.4E-20	4.1%	2.0E+00	2.2E-08
256	10.0%	-3.4E-14	7.6E-23	0.0%	2.8E+03	2.2E-08
0.16	6.8%					
0.060	3.0%	1.5E-09	7.8E-21	1.3%	2.1E+00	2.2E-08
6.9	5.1%	6.1E-13	1.8E-23	0.0%	1.4E+02	2.2E-08
0.095	4.1%					
0.0189	2.0%	2.3E-08	1.9E-19	32.6%	9.8E-01	2.3E-08
0.017	2.0%	2.6E-08	1.9E-19	33.1%	8.7E-01	2.3E-08
0.00005	0.6%	2.6E-06	1.7E-20	2.9%	8.5E-03	2.2E-08
0.00005	0.0%	-9.2E-08	2.1E-23	0.0%	2.4E-01	2.2E-08
0.000046	1.0%	4.8E-06	4.9E-20	8.4%	4.6E-03	2.2E-08
1.2	1.2%	-2.2E-10	7.2E-20	12.3%	1.0E+02	2.2E-08
$u_c(y)$	$u_{c\,r}(y)$			Σ		
7.7E-10	3.5%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	5.5E-02	4.3E-06	1.2%	-4.3E-01	9.6E-01
0.057	1.8%	0.0E+00	0.0E+00	0.0%	-3.2E+00	9.6E-01
0.020	4.8%	-4.2E-02	-1.2E-06	-0.3%	4.2E-01	9.6E-01
0.0022	6.9%	-7.4E-02	2.1E-07	0.1%	-3.0E-02	9.6E-01
0.000075	13.1%	-9.7E-02	-8.5E-09	0.0%	6.5E-04	9.6E-01
0.00012	0.0%	-7.0E-01	6.5E-09	0.0%	1.2E+00	9.6E-01
0.00012	0.0%	7.2E-01	6.9E-09	0.0%	1.1E+00	9.6E-01
0.29		4.6E-02	1.8E-04	49.2%	2.9E-01	9.7E-01
0.29		-4.6E-02	1.8E-04	49.9%	2.9E-01	9.4E-01
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					

0.0000	0.0%					
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.3E-02	9.6E-01
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.4E-02	9.6E-01
$u_c(y)$	$u_{c\,r}(y)$			Σ		
0.019	2.0%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	-0.1901	1.7E-05	5.9%	-4.3E-01	8.5E-01
0.057	1.8%	-0.1427	-1.4E-05	-4.9%	-3.2E+00	8.5E-01
0.020	4.8%	-0.1070	3.0E-06	1.0%	4.2E-01	8.6E-01
0.0022	6.9%	-0.0803	-2.2E-07	-0.1%	-3.0E-02	8.6E-01
0.000075	13.1%	-0.0603	5.0E-09	0.0%	6.5E-04	8.6E-01
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0.1	0.0%	0.0001	1.2E-10	0.0%	1.3E+03	8.6E-01
0.012	1.2%	-0.1426	2.7E-06	0.9%	1.0E+00	8.6E-01
0.012	1.2%	-0.1426	2.7E-06	0.9%	1.0E+00	8.6E-01
0.023	11.5%	0.7343	2.8E-04	96.2%	2.2E-01	8.7E-01
$u_c(y)$	$u_r(y)$			Σ		
0.017	2.0%			100.0%		

	t_c / s	t_l / s	$t_{dead\ r}$ / %	t_d / s	t_c / $t_{1/2}$	t_d / $t_{1/2}$
10:39 AM	1292628	1264268	2.2%	2404405	0.06	0.1
4:52 PM	797	740	7.2%	3722775	0.00	0.0

Correlation matrix of ρ_a

x_i-u(x_i)	y(x_i-u(x_i))		t_i	μ	$t_{1/2\ a}$	$t_{1/2\ m}$
2.2E+04	2.2E-08	t_i	1	0	0	0
4.4E-02	2.2E-08	μ	0	1	0	0
2.1E+07	2.2E-08	$t_{1/2\ a}$	0	0	1	0
		$t_{1/2\ m}$	0	0	0	1
1.7E+08	2.2E-08	$t_{d\ a}$	0	0	0	0
		$t_{c\ a}$	0	0	0	0
2.4E+06	2.2E-08	$t_{l\ a}$	0	0	0	0
1.3E+06	2.2E-08	$t_{d\ m}$	0	0	0	0
1.3E+06	2.2E-08	$t_{c\ m}$	0	0	0	0
3.7E+06	2.2E-08	$t_{l\ m}$	0	0	0	0
8.0E+02	2.2E-08	$n_{p\ a}$	0	0	0	0
7.4E+02	2.2E-08	$n_{p\ m}$	0	0	0	0
		$k_{0\ Au}$(a)	0	0	0	0
		$k_{0\ Au}$(m)	0	0	0	0
		$G_{th\ a}$	0	0	0	0
		$G_{e\ a}$	0	0	0	0
1.2E+05	2.2E-08	$G_{th\ m}$	0	0	0	0
1.4E+05	2.2E-08	$G_{e\ m}$	0	0	0	0
5.7E-03	2.2E-08	f	0	0	0	0
1.3E+00	2.2E-08	α	0	0	0	0
1.0E+00	2.2E-08	$Q_{0\ a}$	0	0	0	0

1.0E+00	2.2E-08	$E_{r\,a}$	0	0	0	0
1.0E+00	2.2E-08	$Q_{0\,m}$	0	0	0	0
1.0E+00	2.2E-08	$E_{r\,m}$	0	0	0	0
1.5E+01	2.2E-08	$\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}$	0	0	0	0
-4.2E-02	2.2E-08	COI_m / COI_a	0	0	0	0
1.8E+00	2.2E-08	m_m	0	0	0	0
2.3E+03	2.2E-08	m_a	0	0	0	0
		w_m	0	0	0	0
1.9E+00	2.2E-08	υ	0	0	0	0
1.3E+02	2.2E-08					
9.4E-01	2.2E-08					
8.4E-01	2.2E-08					
8.4E-03	2.2E-08					
2.4E-01	2.2E-08					
4.6E-03	2.2E-08					
9.8E+01	2.2E-08					

Correlation matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

x_i-u(x_i)	y(x_i-u(x_i))		a_1	a_0	a_{-1}	a_{-2}
-5.2E-01	9.6E-01	a_1	1.000	-0.973	0.884	-0.804
-3.3E+00	9.6E-01	a_0	-0.973	1.000	-0.957	0.896
3.8E-01	9.6E-01	a_{-1}	0.884	-0.957	1.000	-0.984
-3.4E-02	9.6E-01	a_{-2}	-0.804	0.896	-0.984	1.000
5.0E-04	9.6E-01	a_{-3}	0.748	-0.848	0.957	-0.993
1.2E+00	9.6E-01	$E_{\gamma\,m}$	0	0	0	0
1.1E+00	9.6E-01	$E_{\gamma\,a}$	0	0	0	0
-2.9E-01	9.5E-01	Δd_a	0	0	0	0
-2.9E-01	9.7E-01	Δd_m	0	0	0	0
		$\delta\varepsilon_{r\,a}$	0	0	0	0
		$\delta\varepsilon_{r\,m}$	0	0	0	0

4.2E-02	9.6E-01
4.3E-02	9.6E-01

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	8.7E-01
-3.3E+00	8.7E-01
3.8E-01	8.6E-01
-3.4E-02	8.6E-01
5.0E-04	8.6E-01
1.3E+03	8.6E-01
9.9E-01	8.6E-01
9.9E-01	8.6E-01
1.7E-01	8.4E-01

Correlation matrix of COI_m / COI_a

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma 2\ m}$	0	0	0	0
$a_{\gamma 2\ m}$	0	0	0	0
$c_{\gamma 2\ m}$	0	0	0	0
$P/T_{\gamma 2\ m}$	0	0	0	0

$t_{d\,a}$	$t_{c\,a}$	$t_{l\,a}$	$t_{d\,m}$	$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

a_{-3}	$E_{\gamma m}$	$E_{\gamma a}$	Δd_a	Δd_m	$\delta\varepsilon_{r a}$	$\delta\varepsilon_{r m}$	c_i
0.748	0	0	0	0	0	0	5.5E-02
-0.848	0	0	0	0	0	0	0.0E+00
0.957	0	0	0	0	0	0	-4.2E-02
-0.993	0	0	0	0	0	0	-7.4E-02
1.000	0	0	0	0	0	0	-9.7E-02
0	1	0	0	0	0	0	-7.0E-01
0	0	1	0	0	0	0	7.2E-01
0	0	0	1	0	0	0	4.6E-02
0	0	0	0	1	0	0	-4.6E-02
0	0	0	0	0	1	1	0.0E+00
0	0	0	0	0	1	1	0.0E+00

Covariance

a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	c_i	
0.748	0	0	0	0	-1.9E-01	a_1
-0.848	0	0	0	0	-1.4E-01	a_0
0.957	0	0	0	0	-1.1E-01	a_{-1}
-0.993	0	0	0	0	-8.0E-02	a_{-2}
1.000	0	0	0	0	-6.0E-02	a_{-3}
0	1	0	0	0	9.6E-05	$E_{\gamma 2\ m}$
0	0	1	0	0	-1.4E-01	$a_{\gamma 2\ m}$
0	0	0	1	0	-1.4E-01	$c_{\gamma 2\ m}$
0	0	0	0	1	7.3E-01	$P/T_{\gamma 2\ m}$

c_i

$k_{0\,Au}$(m)	$G_{th\,a}$	$G_{e\,a}$	$G_{th\,m}$	$G_{e\,m}$	f	α	$Q_{0\,a}$	$E_{r\,a}$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0

0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Covariance matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

	a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma\,m}$	$E_{\gamma\,a}$
a_1	1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00
a_0	-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00
a_{-1}	7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00
a_{-3}	2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00
$E_{\gamma\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08	0.0E+00
$E_{\gamma\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08
Δd_a	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Δd_m	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
c_i	5.5E-02	0.0E+00	-4.2E-02	-7.4E-02	-9.7E-02	-7.0E-01	7.2E-01

matrix of COI_m/COI_a

a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma2\ m}$	$a_{\gamma2\ m}$	$c_{\gamma2\ m}$	$P/T_{\gamma2\ m}$
1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-04
-1.9E-01	-1.4E-01	-1.1E-01	-8.0E-02	-6.0E-02	9.6E-05	-1.4E-01	-1.4E-01	7.3E-01

$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	COI_m / COI_a	m_m	m_a	w_m
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

0	0	0	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	1	0	0	0	0
0	0	0	1	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	1	0
0	0	0	0	0	0	1
0	0	0	0	0	0	0

Δd_a	Δd_m	$\delta \varepsilon_{r\,a}$	$\delta \varepsilon_{r\,m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	3.1E-05	3.1E-05
0.0E+00	0.0E+00	3.1E-05	3.1E-05
4.6E-02	-4.6E-02	0.0E+00	0.0E+00

Covariance matrix of ρ_a

υ	c_i		t_i	μ
0	3.2E-16	t_i	3.0E+02	0.0E+00
0	-1.1E-09	μ	0.0E+00	2.5E-07
0	9.5E-16	$t_{1/2\ a}$	0.0E+00	0.0E+00
0	-1.3E-16	$t_{1/2\ m}$	0.0E+00	0.0E+00
0	7.3E-16	$t_{d\ a}$	0.0E+00	0.0E+00
0	1.1E-15	$t_{c\ a}$	0.0E+00	0.0E+00
0	-1.8E-14	$t_{l\ a}$	0.0E+00	0.0E+00
0	-9.2E-17	$t_{d\ m}$	0.0E+00	0.0E+00
0	-1.2E-12	$t_{c\ m}$	0.0E+00	0.0E+00
0	3.1E-11	$t_{l\ m}$	0.0E+00	0.0E+00
0	1.8E-13	$n_{p\ a}$	0.0E+00	0.0E+00
0	-1.6E-13	$n_{p\ m}$	0.0E+00	0.0E+00
0	-3.9E-06	$k_{0\ Au}(a)$	0.0E+00	0.0E+00
0	1.7E-08	$k_{0\ Au}(m)$	0.0E+00	0.0E+00
0	-1.9E-08	$G_{th\ a}$	0.0E+00	0.0E+00
0	-3.0E-09	$G_{e\ a}$	0.0E+00	0.0E+00
0	1.9E-08	$G_{th\ m}$	0.0E+00	0.0E+00
0	2.9E-09	$G_{e\ m}$	0.0E+00	0.0E+00
0	6.6E-12	f	0.0E+00	0.0E+00
0	7.6E-09	α	0.0E+00	0.0E+00
0	-1.6E-09	$Q_{0\ a}$	0.0E+00	0.0E+00

0	-3.4E-14	$E_{r\ a}$	0.0E+00	0.0E+00
0	1.5E-09	$Q_{0\ m}$	0.0E+00	0.0E+00
0	6.1E-13	$E_{r\ m}$	0.0E+00	0.0E+00
0	2.3E-08	$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$	0.0E+00	0.0E+00
0	2.6E-08	COI_m / COI_a	0.0E+00	0.0E+00
0	2.6E-06	m_m	0.0E+00	0.0E+00
0	-9.2E-08	m_a	0.0E+00	0.0E+00
0	4.8E-06	w_m	0.0E+00	0.0E+00
1	-2.2E-10	υ	0.0E+00	0.0E+00
		$\mathbf{c}_i$	3.2E-16	-1.1E-09

$t_{1/2\ a}$	$t_{1/2\ m}$	$t_{d\ a}$	$t_{c\ a}$	$t_{l\ a}$	$t_{d\ m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
7.5E+07	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	6.7E+08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.2E+03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E+03
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9.5E-16	-1.3E-16	7.3E-16	1.1E-15	-1.8E-14	-9.2E-17

$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$	$k_{0\,Au}(m)$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.2E+05	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.9E+05	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-10	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.8E-05
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.2E-12	3.1E-11	1.8E-13	-1.6E-13	-3.9E-06	1.7E-08

$G_{th\ a}$	$G_{e\ a}$	$G_{th\ m}$	$G_{e\ m}$	f
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E-01
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.9E-08	-3.0E-09	1.9E-08	2.9E-09	6.6E-12

α	Q_{0a}	E_{ra}	Q_{0m}	E_{rm}	$\varepsilon_{pm}^{geo} / \varepsilon_{pa}^{geo}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	9.1E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	6.6E+04	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	3.6E-03	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.8E+01	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.6E-04
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
7.6E-09	-1.6E-09	-3.4E-14	1.5E-09	6.1E-13	2.3E-08

COI_m / COI_a	m_m	m_a	w_m	υ
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2.9E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	2.5E-09	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.5E-09	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	2.1E-09	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.4E+00
2.6E-08	2.6E-06	-9.2E-08	4.8E-06	-2.2E-10

Irradiation and γ-spectrometry

end irradiation		9/12/2017	2.46 PM
irradiation time / s		21600	

library	CSF.Lib
calib	OR50_source2016_geom_cont_12052017.Clb
sm type	CSF.Lib (ROI32 Analysis)

Nuclide	Channel	Energy	Background
Co60	4692.95	1173.2	43993
Co60	4691.96	1173.2	5220

	target	product
analite, a	^{59}Co	^{60}Co
monitor, m	^{59}Co	^{60}Co

Uncertainty budget of ρ_a

Input Quantity X_i	**Quantity** X_i	**Unit** $[X_i]$	**Value** x_i
t_i		s	21600
μ		1	0.0445
$t_{1/2\ a}$		s	166345920
	λ_a	s^{-1}	4.2E-09
$t_{1/2\ m}$		s	1.7E+08
	λ_m	s^{-1}	4.2E-09
$t_{d\ a}$		s	2404405
$t_{c\ a}$		s	1292628
$t_{l\ a}$		s	1264268
$t_{d\ m}$		s	3722775
$t_{c\ m}$		s	797
$t_{l\ m}$		s	740
	δ_a	1	1.022
	δ_m	1	1.077
	ξ_a	1	1.00098
	ξ_m	1	1.00319
$n_{p\ a}$		1	4676
$n_{p\ m}$		1	137487
$k_{0\ Au}(a)$		1	1.3200
$k_{0\ Au}(m)$		1	1.3200
$G_{th\ a}$		1	1

$G_{e\ a}$		1	1
$G_{th\ m}$		1	1
$G_{e\ m}$		1	1
f		1	15.60
α		1	-0.0360
$Q_{0\ a}$		1	1.993
$E_{r\ a}$		eV	136.0
	$Q_{0\ a}(\alpha)$	1	2.32
$Q_{0\ m}$		1	1.993
$E_{r\ m}$		eV	136.0
	$Q_{0\ m}(\alpha)$	1	2.319
$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$		1	1.0000
COI_m / COI_a		1	1.000
m_m		g	0.00847
m_a		g	0.24000
w_m		$g\ g^{-1}$	0.004597
υ		$mg\ L^{-1}$	99.2
Y		[Y]	y
ρ_a		$g\ mL^{-1}$	3.24E-11

Uncertainty budget of $\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$

Input Quantity	**Quantity**	**Unit**	**Value**
X_i	X_i	$[X_i]$	x_i
a_1		Mev-1	-0.472
a_0		1	-3.229
a_{-1}		Mev	0.403
a_{-2}		Mev2	-0.0320
a_{-3}		Mev3	0.000573
$E_{\gamma\ m}$		MeV	1.17320
$E_{\gamma\ a}$		MeV	1.17320
Δd_a		mm	0
Δd_m		mm	0
	e_4	keV-4	-7.1E-11
	e_3	keV-3	5.2E-08
	e_2	keV-2	-1.4E-05
	e_1	keV-1	1.8E-03
	e_0	1	-4.5E-02
	d_1	keV-1	5.6E-06

	d_0		1	4.2E-02
$\delta\varepsilon_{r\ a}$		mm^{-1}		0.048
$\delta\varepsilon_{r\ m}$		mm^{-1}		0.048
Y		[Y]	y	
$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$		1		1.000

Uncertainty budget of COI_m / COI_a

Input Quantity	Quantity X_i	Unit $[X_i]$	Value x_i	
a_1		Mev-1		-0.472
a_0			1	-3.229
a_{-1}		Mev		0.403
a_{-2}		Mev2		-0.0320
a_{-3}		Mev3		0.000573
	b_1		1	-0.571
	b_0		1	1.079
	c_2		1	-1.625
	c_1		1	6.678
	c_0		1	-7.006
$E_{\gamma 2\ m}$		keV		1332.5
$a_{\gamma 2\ m}$			1	1.000
$c_{\gamma 2\ m}$			1	1.000
$P/T_{\gamma 2\ m}$			1	0.197
$E_{\gamma 2\ a}$		keV		1332.5
$a_{\gamma 2\ a}$			1	1.000
$c_{\gamma 2\ a}$			1	1.000
$P/T_{\gamma 2\ a}$			1	0.197
	Y	[Y]	y	
	COI_m / COI_a		1	1.000

Net area	Cnts/s	Uncert %	FWHM	source file	start counting
4676	0.004	9.36	1.630	OR50_20171025_CSF_s	10/10/2017
137487	185.919	0.32	1.798	OR50_20170925_Co_sa	10/25/2017

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
17	0.1%	1.9E-28	1.0E-53	0.0%	2.2E+04	3.2E-11
0.0005	1.1%	-1.6E-12	6.5E-31	0.0%	4.5E-02	3.2E-11
25920	0.0%	1.9E-19	7.1E-32	0.0%	1.7E+08	3.2E-11
6.5E-13	0.0%					
2.6E+04	0.0%	-1.9E-19	-7.0E-32	0.0%	1.7E+08	3.2E-11
6.5E-13	0.0%					
35	0.0%	1.4E-19	2.2E-35	0.0%	2.4E+06	3.2E-11
0.3	0.0%	1.2E-18	1.1E-37	0.0%	1.3E+06	3.2E-11
0.3	0.0%	-2.7E-17	6.0E-35	0.0%	1.3E+06	3.2E-11
35	0.0%	-1.4E-19	2.2E-35	0.0%	3.7E+06	3.2E-11
0.3	0.0%	-1.7E-15	2.4E-31	0.0%	8.0E+02	3.2E-11
0.3	0.0%	4.6E-14	1.7E-28	0.0%	7.4E+02	3.2E-11
0.000	0.0%					
0.001	0.1%					
0.00001	0.0%					
0.00004	0.0%					
438	9.4%	6.9E-15	9.2E-24	92.8%	5.1E+03	3.5E-11
440	0.3%	-2.4E-16	1.1E-26	0.1%	1.4E+05	3.2E-11
0.0053	0.4%	-2.5E-11	2.7E-31	0.0%	1.3E+00	3.2E-11
0.0053	0.4%	2.5E-11	-2.7E-31	0.0%	1.3E+00	3.3E-11
0	0.0%	-2.8E-11	0.0E+00	0.0%	1.0E+00	3.2E-11

0	0.0%	-4.2E-12	0.0E+00	0.0%	1.0E+00	3.2E-11
0	0.0%	2.8E-11	0.0E+00	0.0%	1.0E+00	3.2E-11
0	0.0%	4.2E-12	0.0E+00	0.0%	1.0E+00	3.2E-11
0.33	2.1%	0.0E+00	0.0E+00	0.0%	1.6E+01	3.2E-11
0.0064	17.8%	0.0E+00	0.0E+00	0.0%	-3.0E-02	3.2E-11
0.060	3.0%	-2.2E-12	2.6E-31	0.0%	2.1E+00	3.2E-11
6.9	5.1%	-8.9E-16	3.6E-34	0.0%	1.4E+02	3.2E-11
0.10	4.1%					
0.060	3.0%	2.2E-12	-2.6E-31	0.0%	2.1E+00	3.3E-11
6.9	5.1%	8.9E-16	-3.6E-34	0.0%	1.4E+02	3.2E-11
0.095	4.1%					
0.0197	2.0%	3.2E-11	4.1E-25	4.1%	1.0E+00	3.3E-11
0.000	0.0%	3.2E-11	9.5E-30	0.0%	1.0E+00	3.2E-11
0.00005	0.6%	3.8E-09	3.7E-26	0.4%	8.5E-03	3.3E-11
0.00005	0.0%	-1.4E-10	4.6E-29	0.0%	2.4E-01	3.2E-11
0.000046	1.0%	7.0E-09	1.1E-25	1.1%	4.6E-03	3.3E-11
1.2	1.2%	-3.3E-13	1.5E-25	1.6%	1.0E+02	3.2E-11
$u_c(y)$	$u_{c\,r}(y)$		Σ			
3.1E-12	9.7%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	0.0E+00	0.0E+00	0.0%	-4.3E-01	1.0E+00
0.057	1.8%	0.0E+00	0.0E+00	0.0%	-3.2E+00	1.0E+00
0.020	4.8%	0.0E+00	0.0E+00	0.0%	4.2E-01	1.0E+00
0.0022	6.9%	0.0E+00	0.0E+00	0.0%	-3.0E-02	1.0E+00
0.000075	13.1%	0.0E+00	0.0E+00	0.0%	6.5E-04	1.0E+00
0.00012	0.0%	-7.3E-01	7.0E-09	0.0%	1.2E+00	1.0E+00
0.00012	0.0%	7.3E-01	7.0E-09	0.0%	1.2E+00	1.0E+00
0.29		4.8E-02	1.9E-04	50.0%	2.9E-01	1.0E+00
0.29		-4.8E-02	1.9E-04	50.0%	2.9E-01	9.9E-01
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					
0.0000	0.0%					

0.0000	0.0%					
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.4E-02	1.0E+00
0.006	11.5%	0.0E+00	0.0E+00	0.0%	5.4E-02	1.0E+00
$u_c(y)$	$u_{c\ r}(y)$			Σ		
0.020	2.0%			100.0%		

Std unc	Rel std unc	**Sensit coeff**	Variance y	**Index**	Input for sensit coeff	
$u(x_i)$	$u_r(x_i)$	**c_i**	$u^2_y(x_i)$		$x_i+u(x_i)$	$y(x_i+u(x_i))$
0.043	9.2%	0.0000	0.0E+00	0.0%	-4.3E-01	1.0E+00
0.057	1.8%	0.0000	0.0E+00	0.0%	-3.2E+00	1.0E+00
0.020	4.8%	0.0000	0.0E+00	0.0%	4.2E-01	1.0E+00
0.0022	6.9%	0.0000	0.0E+00	0.0%	-3.0E-02	1.0E+00
0.000075	13.1%	0.0000	0.0E+00	0.0%	6.5E-04	1.0E+00
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0	0.0%					
0.1	0.0%	0.0001	-3.0E-19	0.0%	1.3E+03	1.0E+00
0.012	1.2%	-0.1663	-1.4E-11	-0.1%	1.0E+00	1.0E+00
0.012	1.2%	-0.1663	-1.4E-11	-0.1%	1.0E+00	1.0E+00
0.023	11.5%	0.8564	-1.9E-06	-20439%	2.2E-01	1.0E+00
0.12	0.0%	-0.0001	3.0E-19	0.0%	1.3E+03	1.0E+00
0.012	1.2%	0.1663	1.4E-11	0.1%	1.0E+00	1.0E+00
0.012	1.2%	0.1663	1.4E-11	0.1%	1.0E+00	1.0E+00
0.023	11.5%	-0.8606	1.9E-06	20539%	2.2E-01	9.8E-01
$u_c(y)$	$u_r(y)$			Σ		
0.000	0.0%			100.0%		

	t_c / s	t_l / s	$t_{dead\ r}$ / %	t_d / s	t_c / $t_{1/2}$	t_d / $t_{1/2}$
10:39 AM	1292628	1264268	2.2%	2404405	0.01	0.0
4:52 PM	797	740	7.2%	3722775	0.00	0.0

Correlation matrix of ρ_a

x_i-u(x_i)	y(x_i-u(x_i))		t_i	μ	$t_{1/2\ a}$	$t_{1/2\ m}$
2.2E+04	3.2E-11	t_i	1	0	0	0
4.4E-02	3.2E-11	μ	0	1	0	0
1.7E+08	3.2E-11	$t_{1/2\ a}$	0	0	1	1
		$t_{1/2\ m}$	0	0	1	1
1.7E+08	3.2E-11	$t_{d\ a}$	0	0	0	0
		$t_{c\ a}$	0	0	0	0
2.4E+06	3.2E-11	$t_{l\ a}$	0	0	0	0
1.3E+06	3.2E-11	$t_{d\ m}$	0	0	0	0
1.3E+06	3.2E-11	$t_{c\ m}$	0	0	0	0
3.7E+06	3.2E-11	$t_{l\ m}$	0	0	0	0
8.0E+02	3.2E-11	$n_{p\ a}$	0	0	0	0
7.4E+02	3.2E-11	$n_{p\ m}$	0	0	0	0
		$k_{0\ Au}$(a)	0	0	0	0
		$k_{0\ Au}$(m)	0	0	0	0
		$G_{th\ a}$	0	0	0	0
		$G_{e\ a}$	0	0	0	0
4.2E+03	2.9E-11	$G_{th\ m}$	0	0	0	0
1.4E+05	3.3E-11	$G_{e\ m}$	0	0	0	0
1.3E+00	3.3E-11	f	0	0	0	0
1.3E+00	3.2E-11	α	0	0	0	0
1.0E+00	3.2E-11	$Q_{0\ a}$	0	0	0	0

1.0E+00	3.2E-11
1.0E+00	3.2E-11
1.0E+00	3.2E-11
1.5E+01	3.2E-11
-4.2E-02	3.2E-11
1.9E+00	3.3E-11
1.3E+02	3.2E-11
1.9E+00	3.2E-11
1.3E+02	3.2E-11
9.8E-01	3.2E-11
1.0E+00	3.2E-11
8.4E-03	3.2E-11
2.4E-01	3.2E-11
4.6E-03	3.2E-11
9.8E+01	3.3E-11

$E_{r\,a}$	0	0	0	0
$Q_{0\,m}$	0	0	0	0
$E_{r\,m}$	0	0	0	0
$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}$	0	0	0	0
COI_m / COI_a	0	0	0	0
m_m	0	0	0	0
m_a	0	0	0	0
w_m	0	0	0	0
υ	0	0	0	0

Correlation matrix of $\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	1.0E+00
-3.3E+00	1.0E+00
3.8E-01	1.0E+00
-3.4E-02	1.0E+00
5.0E-04	1.0E+00
1.2E+00	1.0E+00
1.2E+00	1.0E+00
-2.9E-01	9.9E-01
-2.9E-01	1.0E+00

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma\,m}$	0	0	0	0
$E_{\gamma\,a}$	0	0	0	0
Δd_a	0	0	0	0
Δd_m	0	0	0	0
$\delta\varepsilon_{r\,a}$	0	0	0	0
$\delta\varepsilon_{r\,m}$	0	0	0	0

4.3E-02	1.0E+00
4.3E-02	1.0E+00

Correlation matrix of COI_m / COI_a

x_i-u(x_i)	y(x_i-u(x_i))
-5.2E-01	1.0E+00
-3.3E+00	1.0E+00
3.8E-01	1.0E+00
-3.4E-02	1.0E+00
5.0E-04	1.0E+00
1.3E+03	1.0E+00
9.9E-01	1.0E+00
9.9E-01	1.0E+00
1.7E-01	9.8E-01
1.3E+03	1.0E+00
9.9E-01	1.0E+00
9.9E-01	1.0E+00
1.7E-01	1.0E+00

	a_1	a_0	a_{-1}	a_{-2}
a_1	1.000	-0.973	0.884	-0.804
a_0	-0.973	1.000	-0.957	0.896
a_{-1}	0.884	-0.957	1.000	-0.984
a_{-2}	-0.804	0.896	-0.984	1.000
a_{-3}	0.748	-0.848	0.957	-0.993
$E_{\gamma 2\ m}$	0	0	0	0
$a_{\gamma 2\ m}$	0	0	0	0
$c_{\gamma 2\ m}$	0	0	0	0
$P/T_{\gamma 2\ m}$	0	0	0	0
$E_{\gamma 2\ a}$	0	0	0	0
$a_{\gamma 2\ a}$	0	0	0	0
$c_{\gamma 2\ a}$	0	0	0	0
$P/T_{\gamma 2\ a}$	0	0	0	0

$t_{d\,a}$	$t_{c\,a}$	$t_{l\,a}$	$t_{d\,m}$	$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

a_{-3}	$E_{\gamma m}$	$E_{\gamma a}$	Δd_a	Δd_m	$\delta\varepsilon_{r a}$	$\delta\varepsilon_{r m}$	c_i
0.748	0	0	0	0	0	0	0.0E+00
-0.848	0	0	0	0	0	0	0.0E+00
0.957	0	0	0	0	0	0	0.0E+00
-0.993	0	0	0	0	0	0	0.0E+00
1.000	0	0	0	0	0	0	0.0E+00
0	1	0	0	0	0	0	-7.3E-01
0	0	1	0	0	0	0	7.3E-01
0	0	0	1	0	0	0	4.8E-02
0	0	0	0	1	0	0	-4.8E-02
0	0	0	0	0	1	1	0.0E+00
0	0	0	0	0	1	1	0.0E+00

a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	$E_{\gamma 2\ a}$	$a_{\gamma 2\ a}$	$c_{\gamma 2\ a}$	$P/T_{\gamma 2\ a}$
0.748	0	0	0	0	0	0	0	0
-0.848	0	0	0	0	0	0	0	0
0.957	0	0	0	0	0	0	0	0
-0.993	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0
0	0	1	0	0	0	1	0	0
0	0	0	1	0	0	0	1	0
0	0	0	0	1	0	0	0	1
0	1	0	0	0	1	0	0	0
0	0	1	0	0	0	1	0	0
0	0	0	1	0	0	0	1	0
0	0	0	0	1	0	0	0	1

$k_{0\,Au}$(m)	$G_{th\,a}$	$G_{e\,a}$	$G_{th\,m}$	$G_{e\,m}$	f	α	$Q_{0\,a}$	$E_{r\,a}$
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	0

0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Covariance matrix of $\varepsilon_{p\,m}^{geo}$ / $\varepsilon_{p\,a}^{geo}$

	a_1	a_0	a_{-1}	a_{-2}	a_{-3}	$E_{\gamma\,m}$	$E_{\gamma\,a}$
a_1	1.9E-03	-2.4E-03	7.5E-04	-7.7E-05	2.4E-06	0.0E+00	0.0E+00
a_0	-2.4E-03	3.2E-03	-1.1E-03	1.1E-04	-3.6E-06	0.0E+00	0.0E+00
a_{-1}	7.5E-04	-1.1E-03	3.8E-04	-4.3E-05	1.4E-06	0.0E+00	0.0E+00
a_{-2}	-7.7E-05	1.1E-04	-4.3E-05	4.9E-06	-1.7E-07	0.0E+00	0.0E+00
a_{-3}	2.4E-06	-3.6E-06	1.4E-06	-1.7E-07	5.7E-09	0.0E+00	0.0E+00
$E_{\gamma\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08	0.0E+00
$E_{\gamma\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-08
Δd_a	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Δd_m	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,a}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
$\delta\varepsilon_{r\,m}$	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
c_i	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-7.3E-01	7.3E-01

Covariance matrix of COI_m/COI_a

c_i		a_1	a_0	a_{-1}
0.0E+00	a_1	1.9E-03	-2.4E-03	7.5E-04
0.0E+00	a_0	-2.4E-03	3.2E-03	-1.1E-03
0.0E+00	a_{-1}	7.5E-04	-1.1E-03	3.8E-04
0.0E+00	a_{-2}	-7.7E-05	1.1E-04	-4.3E-05
0.0E+00	a_{-3}	2.4E-06	-3.6E-06	1.4E-06
1.1E-04	$E_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
-1.7E-01	$a_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
-1.7E-01	$c_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
8.6E-01	$P/T_{\gamma 2\ m}$	0.0E+00	0.0E+00	0.0E+00
-1.1E-04	$E_{\gamma 2\ a}$	0.0E+00	0.0E+00	0.0E+00
1.7E-01	$a_{\gamma 2\ a}$	0.0E+00	0.0E+00	0.0E+00
1.7E-01	$c_{\gamma 2\ a}$	0.0E+00	0.0E+00	0.0E+00
-8.6E-01	$P/T_{\gamma 2\ a}$	0.0E+00	0.0E+00	0.0E+00
	c_i	0.0E+00	0.0E+00	0.0E+00

$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	COI_m / COI_a	m_m	m_a	w_m
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	0	0	0	0	0	0

0	1	0	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	1	0	0	0	0
0	0	0	1	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	1	0
0	0	0	0	0	0	1
0	0	0	0	0	0	0

Δd_a	Δd_m	$\delta\varepsilon_{r\,a}$	$\delta\varepsilon_{r\,m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	3.1E-05	3.1E-05
0.0E+00	0.0E+00	3.1E-05	3.1E-05
4.8E-02	-4.8E-02	0.0E+00	0.0E+00

a_{-2}	a_{-3}	$E_{\gamma 2\ m}$	$a_{\gamma 2\ m}$	$c_{\gamma 2\ m}$	$P/T_{\gamma 2\ m}$	$E_{\gamma 2\ a}$
-7.7E-05	2.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.1E-04	-3.6E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-4.3E-05	1.4E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
4.9E-06	-1.7E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.7E-07	5.7E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00	1.3E-02
0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-04	0.0E+00
0.0E+00	0.0E+00	1.3E-02	0.0E+00	0.0E+00	0.0E+00	1.3E-02
0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-04	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.2E-04	0.0E+00
0.0E+00	0.0E+00	1.1E-04	-1.7E-01	-1.7E-01	8.6E-01	-1.1E-04

Covariance matrix of ρ_a

υ	c_i		t_i	μ
0	1.9E-28	t_i	3.0E+02	0.0E+00
0	-1.6E-12	μ	0.0E+00	2.5E-07
0	1.9E-19	$t_{1/2\ a}$	0.0E+00	0.0E+00
0	-1.9E-19	$t_{1/2\ m}$	0.0E+00	0.0E+00
0	1.4E-19	$t_{d\ a}$	0.0E+00	0.0E+00
0	1.2E-18	$t_{c\ a}$	0.0E+00	0.0E+00
0	-2.7E-17	$t_{l\ a}$	0.0E+00	0.0E+00
0	-1.4E-19	$t_{d\ m}$	0.0E+00	0.0E+00
0	-1.7E-15	$t_{c\ m}$	0.0E+00	0.0E+00
0	4.6E-14	$t_{l\ m}$	0.0E+00	0.0E+00
0	6.9E-15	$n_{p\ a}$	0.0E+00	0.0E+00
0	-2.4E-16	$n_{p\ m}$	0.0E+00	0.0E+00
0	-2.5E-11	$k_{0\ Au}$(a)	0.0E+00	0.0E+00
0	2.5E-11	$k_{0\ Au}$(m)	0.0E+00	0.0E+00
0	-2.8E-11	$G_{th\ a}$	0.0E+00	0.0E+00
0	-4.2E-12	$G_{e\ a}$	0.0E+00	0.0E+00
0	2.8E-11	$G_{th\ m}$	0.0E+00	0.0E+00
0	4.2E-12	$G_{e\ m}$	0.0E+00	0.0E+00
0	0.0E+00	f	0.0E+00	0.0E+00
0	0.0E+00	α	0.0E+00	0.0E+00
0	-2.2E-12	$Q_{0\ a}$	0.0E+00	0.0E+00

0	-8.9E-16	$E_{r\ a}$	0.0E+00	0.0E+00
0	2.2E-12	$Q_{0\ m}$	0.0E+00	0.0E+00
0	8.9E-16	$E_{r\ m}$	0.0E+00	0.0E+00
0	3.2E-11	$\varepsilon_{p\ m}^{geo} / \varepsilon_{p\ a}^{geo}$	0.0E+00	0.0E+00
0	3.2E-11	COI_m / COI_a	0.0E+00	0.0E+00
0	3.8E-09	m_m	0.0E+00	0.0E+00
0	-1.4E-10	m_a	0.0E+00	0.0E+00
0	7.0E-09	w_m	0.0E+00	0.0E+00
1	-3.3E-13	υ	0.0E+00	0.0E+00
		$\mathbf{c}_i$	1.9E-28	-1.6E-12

$a_{\gamma 2\ a}$	$c_{\gamma 2\ a}$	$P/T_{\gamma 2\ a}$
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00
1.3E-04	0.0E+00	0.0E+00
0.0E+00	1.3E-04	0.0E+00
0.0E+00	0.0E+00	5.2E-04
0.0E+00	0.0E+00	0.0E+00
1.3E-04	0.0E+00	0.0E+00
0.0E+00	1.3E-04	0.0E+00
0.0E+00	0.0E+00	5.2E-04
1.7E-01	1.7E-01	-8.6E-01

$t_{1/2\ a}$	$t_{1/2\ m}$	$t_{d\ a}$	$t_{c\ a}$	$t_{l\ a}$	$t_{d\ m}$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
6.7E+08	6.7E+08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
6.7E+08	6.7E+08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.2E+03	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.3E-02	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E+03
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1.9E-19	-1.9E-19	1.4E-19	1.2E-18	-2.7E-17	-1.4E-19

$t_{c\,m}$	$t_{l\,m}$	$n_{p\,a}$	$n_{p\,m}$	$k_{0\,Au}(a)$	$k_{0\,Au}(m)$
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	8.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	1.9E+05	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	1.9E+05	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.8E-05	2.8E-05
0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.8E-05	2.8E-05
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-1.7E-15	4.6E-14	6.9E-15	-2.4E-16	-2.5E-11	2.5E-11

$G_{th\ a}$	$G_{e\ a}$	$G_{th\ m}$	$G_{e\ m}$	f
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E-01
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
-2.8E-11	-4.2E-12	2.8E-11	4.2E-12	0.0E+00

α	$Q_{0\,a}$	$E_{r\,a}$	$Q_{0\,m}$	$E_{r\,m}$	$\varepsilon_{p\,m}^{geo} / \varepsilon_{p\,a}^{geo}$	
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	4.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	0.0E+00	3.6E-03	0.0E+00	3.6E-03	0.0E+00	0.0E+00

0.0E+00	0.0E+00	4.8E+01	0.0E+00	4.8E+01	0.0E+00
0.0E+00	3.6E-03	0.0E+00	3.6E-03	0.0E+00	0.0E+00
0.0E+00	0.0E+00	4.8E+01	0.0E+00	4.8E+01	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.9E-04
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	-2.2E-12	-8.9E-16	2.2E-12	8.9E-16	3.2E-11

COI_m / COI_a	m_m	m_a	w_m	υ
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9.1E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00
0.0E+00	2.5E-09	0.0E+00	0.0E+00	0.0E+00
0.0E+00	0.0E+00	2.5E-09	0.0E+00	0.0E+00
0.0E+00	0.0E+00	0.0E+00	2.1E-09	0.0E+00
0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.4E+00
3.2E-11	3.8E-09	-1.4E-10	7.0E-09	-3.3E-13

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Title page

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An uncertainty spreadsheet for the k0-standardisation method in Neutron Activation Analysis

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Abstract

This paper focuses on the use of the spreadsheet technique to set up the uncertainty budget for the k_0-standardisation method in Neutron Activation Analysis. The adopted measurement model included most of presently recognized error sources and was written to limit the covariances between input quantities. The calculations were implemented in a worksheet file and tested in a multi-elemental analysis of a biological material. Besides, it was demonstrated that the k_0-standardisation turns to the relative-standardisation when the monitor element corresponds to the analyte element. The developed worksheet is available and suitable for the analysis of other materials in different experimental conditions.

Keywords

k_0-standardisation method, uncertainty budget, spreadsheet technique, correlated input quantities, cerebrospinal fluid

Introduction

In 1995, a guide was published by EURACHEM/CITAC [1] to illustrate the use in chemistry measurements of the general rules outlined in the Guide to the Expression of

Uncertainty in Measurement (GUM) [2] for the evaluation and expression of uncertainty. Afterwards, since specific applications in nuclear chemistry measurements were missing in the guide, practical examples for the most common nuclear analytical techniques were included in a report of the International Atomic Energy Agency (IAEA) [3].

The Neutron Activation Analysis (NAA) was addressed in the IAEA report, as regards the existing standardisation methods, i.e. the relative- and k_0-NAA. A detailed list of sources of error were identified and grouped in four categories: i) preparation of samples, ii) neutron irradiation, iii) γ-spectrometry measurements and iv) radiochemical separation, if executed. Two uncertainty budgets were given as examples for the relative-NAA, the first dealing with vanadium in coal fly ash by Instrumental NAA (INAA) and the latter with manganese in animal freeze dried blood by Radiochemical NAA (RNAA). Only one example for the k_0-NAA was cited, with a reference to the (preliminary) evaluation performed by de Corte [4].

Next, several studies focused on the k_0-NAA. Robouch et al [5] suggested the use of the spreadsheet technique developed by Kragten [6] and recommended a general equation to express the uncertainty of the results. Younes et al [7] showed that the sensitivity coefficients, computed by finite difference approximations in the spreadsheet technique, could also be expressed in analytical form. In fact, subsequent works were all based on analytical expressions of the sensitivity coefficients [8, 9].

To date, the most comprehensive examples of uncertainty budgets for k_0-NAA were reported in [9] and concerned the determination of Au, Cr, Rb and Sb in compressed cellulose pellets. The covariances between input quantities, in practice always neglected in the previously available literature, were to some extent considered. However, values and expressions of correlation and sensitivity coefficients were omitted.

In this study, we adopted a measurement equation modeling most of the acknowledged sources of error and written to limit the covariances. Due to the complexity of the resulting functional relationship, we used the spreadsheet technique and the matrix formalism to propagate the uncertainties, including the outstanding correlations. The formulae were implemented and tested for the determination of trace elements in a biological material.

Details on the neutron activation experiment as well as on the characterization of the detection system are here presented to assign estimates, uncertainties and correlation coefficients of the input quantities. Lastly, the uncertainty budgets are briefly discussed to point out the main contributors to the combined uncertainties of the results.

Model

The theoretical basis of k_0-NAA is well established and extensively reported in literature. Simonits et al. proposed the original idea in 1975 [10] following a preliminary study carried out by Girardi et al. [11]. In 1987, de Corte published the most comprehensive development of the method [4], including references to previous papers focused on definitions and assumptions of the standardisation. Here, the basic concepts are briefly recalled to term the input quantities of the measurement model.

The formalism underlying the method is based on a rather simple description of the reaction rate per target nuclide, R, following the Høgdahl convention [12] in the case of a (target) nuclide having a $1/E^{1/2}$ dependence of the (n,γ) cross section function, $\sigma(E)$, versus the neutron energy, E.

According to the convention, the neutron spectrum is divided in the sub- and epi-cadmium regions, respectively below and above the cadmium cut-off energy fixed to 0.55 eV. The fission component is neglected under the hypothesis that the corresponding contribution to R is small. Accordingly:

$$R = G_{\mathrm{th}} \Phi_{\mathrm{s}} \sigma_0 + G_{\mathrm{e}} \Phi_{\mathrm{e}} I_0(\alpha), \tag{1}$$

where Φ_{s} and Φ_{e} are the (conventional) sub- and epi-cadmium neutron fluxes, G_{th} and G_{e} are correction factors accounting for the thermal and epithermal neutron self-shielding, σ_0 is the thermal cross section, and $I_0(\alpha)$ is the resonance integral for a $1/E^{1+\alpha}$ neutron spectrum in the epi-cadmium region.

The knowledge of the time dependence of the amount of produced radionuclide during and after activation combined to the counting of the emitted γ-photons links the number of target nuclides in a sample, N_t, to the number of counts in the full-energy peak of the collected γ-spectrum, n_p, via R.

With the exception of branching activation and mother-daughter decay, and neglecting burn-up effects, the relation between N_t and n_p is:

$$R\, N_\mathrm{t}\, \varepsilon_\mathrm{p}^\mathrm{geo}\, P_\gamma = \frac{\lambda\, n_\mathrm{p}\, (\delta\, \xi / \mathrm{COI})}{\left(1-e^{-\lambda\, t_\mathrm{i}}\right) e^{-\lambda\, t_\mathrm{d}} \left(1-e^{-\lambda\, t_\mathrm{c}}\right)}, \tag{2}$$

where $R\, N_\mathrm{t}$ is the total reaction rate, $\varepsilon_\mathrm{p}^\mathrm{geo}$ is the full-energy γ-peak detection efficiency for the actual position and geometry of the sample, P_γ is the absolute emission probability of the γ-photons, t_c and t_l are the counting and live times of the detection system, t_i is the irradiation time, t_d is the decay time after irradiation, COI is the true-coincidence correction factor, $\lambda = \ln(2)\,/t_{1/2}$ is the decay constant of the produced radionuclide, given its half-life $t_{1/2}$, $\delta = t_\mathrm{c}/t_\mathrm{l}$ is the dead time correction factor and $\xi = e^{\mu(1-t_\mathrm{l}/t_\mathrm{c})}$ is the excess counting loss correction factor, given the excess counting loss constant of the detection system, μ, defined in [13].

In the case that the (target) nuclide is an isotope of an element in a m mass sample, N_t can be expressed as:

$$N_\mathrm{t} = \frac{w\, m\, x\, N_\mathrm{A}}{M}, \tag{3}$$

where x is the abundance of the isotope, N_A is the Avogadro constant, and w and M are the mass fraction and molar mass of the element in the sample, respectively.

From eqs. (1), (2) and (3), it follows:

$$\frac{\sigma_0\, P_\gamma\, x\, N_\mathrm{A}}{M} = \frac{\lambda\, n_\mathrm{p}\, (\delta\, \xi/\mathrm{COI})}{\left(1-e^{-\lambda\, t_\mathrm{i}}\right) e^{-\lambda\, t_\mathrm{d}} \left(1-e^{-\lambda\, t_\mathrm{c}}\right) \varepsilon_\mathrm{p}^\mathrm{geo}} \frac{1}{m\, w} \frac{1}{\Phi_\mathrm{s}\left(G_\mathrm{th} + \frac{G_\mathrm{e} Q_0(\alpha)}{f}\right)}, \tag{4}$$

where $Q_0(\alpha) = I_0(\alpha)/\sigma_0$ and $f = \Phi_\mathrm{s}/\,\Phi_\mathrm{e}$. The $Q_0(\alpha)$ value is obtained by applying the formula $Q_0(\alpha) = (Q_0 - 0.429)\bar{E}_\mathrm{r}^{-\alpha} + 0.429/[0.55^\alpha(1 + 2\,\alpha)]$, where $Q_0 = I_0/\sigma_0$ is the ratio of the resonance integral (for a $1/E$ neutron spectrum in the epi-cadmium region) to the thermal cross section and $\bar{E}_\mathrm{r}$ is the effective resonance energy of the target nuclide.

It is worth remarking that the parameters on the left-hand side of (4) are independent of the experimental conditions of irradiation and γ-counting. In fact, the product $\sigma_0\, P_\gamma\, N_\mathrm{A}$ is a constant quantity and the ratio x/M depends on the isotopic composition.

The k_0-NAA measurement model is derived from the application of (4) to the element to be quantified, i.e. the analyte, and to an element used as a monitor of the of the neutron fluence rate.

The following equation holds under the assumption that analyte and monitor are exposed to the same (constant) values of Φ_s and Φ_e during the irradiation:

$$w_\mathrm{a} = \frac{\left.\frac{\lambda\, n_\mathrm{p}\, \delta\, \xi}{\left(1-e^{-\lambda\, t_\mathrm{i}}\right) e^{-\lambda\, t_\mathrm{d}} \left(1-e^{-\lambda\, t_\mathrm{c}}\right)}\right|_\mathrm{a}}{\left.\frac{\lambda\, n_\mathrm{p}\, \delta\, \xi}{\left(1-e^{-\lambda\, t_\mathrm{i}}\right) e^{-\lambda\, t_\mathrm{d}} \left(1-e^{-\lambda\, t_\mathrm{c}}\right)}\right|_\mathrm{m}} \frac{k_{0\,\mathrm{Au}}(\mathrm{m})}{k_{0\,\mathrm{Au}}(\mathrm{a})} \frac{\left(G_{\mathrm{th\,m}}+\frac{G_{\mathrm{e\,m}}\, Q_{0\,\mathrm{m}}(\alpha)}{f}\right)}{\left(G_{\mathrm{th\,a}}+\frac{G_{\mathrm{e\,a}}\, Q_{0\,\mathrm{a}}(\alpha)}{f}\right)} \frac{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}} \frac{\mathrm{COI_m}}{\mathrm{COI_a}} \frac{m_\mathrm{m}}{m_\mathrm{a}} w_\mathrm{m}, \qquad (5)$$

where the parameters $k_{0\,\mathrm{Au}}(\mathrm{m}) = \frac{M_\mathrm{Au}\, \sigma_{0\,\mathrm{m}}\, P_{\gamma\,\mathrm{m}}\, x_\mathrm{m}}{M_\mathrm{m}\, \sigma_{0\,\mathrm{Au}}\, P_{\gamma\,\mathrm{Au}}\, x_\mathrm{Au}}$ and $k_{0\,\mathrm{Au}}(\mathrm{a}) = \frac{M_\mathrm{Au}\, \sigma_{0\,\mathrm{a}}\, P_{\gamma\,\mathrm{a}}\, x_\mathrm{a}}{M_\mathrm{a}\, \sigma_{0\,\mathrm{Au}}\, P_{\gamma\,\mathrm{Au}}\, x_\mathrm{Au}}$ are the so-called k_0 factors; subscripts a and m refer to the analyte and to the monitor, respectively.

The k_0 values have been experimentally determined for the most important (n,γ) reactions and γ-photons energies with respect to the 411 keV γ-photons emitted by ^{198}Au produced from ^{197}Au via (n,γ) reaction. A compilation of the recommended $k_{0\,\mathrm{Au}}$, Q_0 and $\bar{E}_\mathrm{r}$ values can be found in [14].

Experimental

To exemplify the use of the equation model (5), we measured a lyophilized sample of cerebrospinal fluid (CSF). The experiment was intended to set up the uncertainty budget and not to reach the minimum uncertainty. The results were given in terms of mass concentrations, $\rho_\mathrm{a} = w_\mathrm{a}/\upsilon$, where υ is the factor used to convert the mass of lyophilized CSF to the volume of reconstituted CSF.

Preparation of the samples

Ten vials of lyophilized CSF, each one corresponding to 3 mL volumes of reconstituted CSF, were purchased. The content of every single vial was moved to an acid-cleaned 8 mL cut polyethylene (PE) vial and sealed. The mass to volume conversion factor, $\upsilon = 99.2(12)\ \mathrm{mL\ g^{-1}}$, was obtained as the ratio of 3 mL to the average of the (ten) mass differences between the filled and empty (washed and dried out) vials. Here and hereafter, unless otherwise specified, the brackets refer to the standard uncertainty and apply to the last digits.

One sample, about 28 mm length, of an Al-0.46%Co wire (Reactor Experiment, 99.9313% purity, 0.38 mm diameter) was used as a Co monitor. The weighed mass, $m_\mathrm{m} = 8.47(5)\ \mathrm{mg}$, was sealed in one PE micro-tube. A conservative 1% relative standard uncertainty was assigned to the declared Co mass fraction value, $w_\mathrm{m} = 4.597(46) \times 10^{-3}\ \mathrm{g\ g^{-1}}$.

Neutron irradiation

The neutron irradiation lasted $t_\mathrm{i} = 6.000(5)$ h and was performed in the 250 kW TRIGA Mark II reactor at the Laboratory of Applied Nuclear Energy (LENA) of the University of Pavia. The quoted uncertainty corresponds to a uniform probability distribution assigned to the t_i value and having a 30 s half-width.

The vial containing the lyophilized CSF sample and the micro-tube containing the Al-Co wire were put in one PE container used for irradiation and located in the central channel (CC) of the reactor; the neutron flux parameters at CC, $f = 15.6(3)$ and $\alpha = -0.036(6)$, were recently measured [15]. The position of the lyophilized CSF sample and of the Al-Co wire during the irradiation is shown in Figure 1.

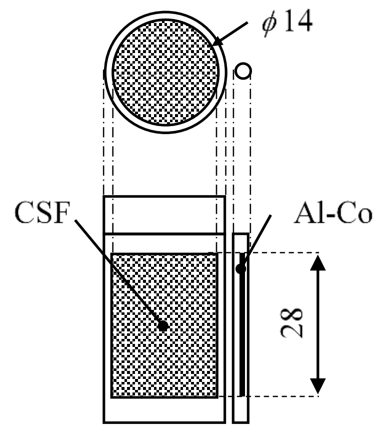

Fig 1 Position of the lyophilized CSF sample and of the Al-Co wire during the irradiation. Dimensions in mm

Gamma spectrometry

After irradiation, the lyophilized CSF sample was moved from its vial to a new 10 mL PE vial and weighed; the mass, m_{a}, was found to be 240.00(5) mg, corresponding to 23.81(28) mL volume of reconstituted CSF in the case of negligible effect due to humidity. The relative loss of sample was about 20%, probably due to the lyophilized CSF residuals in the vials. The Al-Co wire was removed from its micro-tube, placed in a new 10 mL vial and dissolved using a few drops of nitric and hydrochloric acid (1:1) solution. After complete digestion, water was added to obtain the same volume as the lyophilized CSF sample.

The γ-spectra were recorded with a high purity germanium (HPGe) detector, ORTEC GEM50P4-83 (relative efficiency 50%, resolution 1.90 keV at 1332 keV) inside a low-background graded shield. The detector was connected to a digital signal processor ORTEC DSPEC 502 and the data were collected and processed using the ORTEC Gamma Vision software (version 6.08). The acquisition was performed in extended live-time correction mode using the Gedcke-Hale method with pulse pile-up rejection in automatic set threshold; the excess counting loss constant of the detection system, $\mu = 0.0445(5)$, was recently measured [13].

The position of the lyophilized CSF and dissolved Al-Co wire samples with respect to the detector end-cap is shown in Figure 2a.

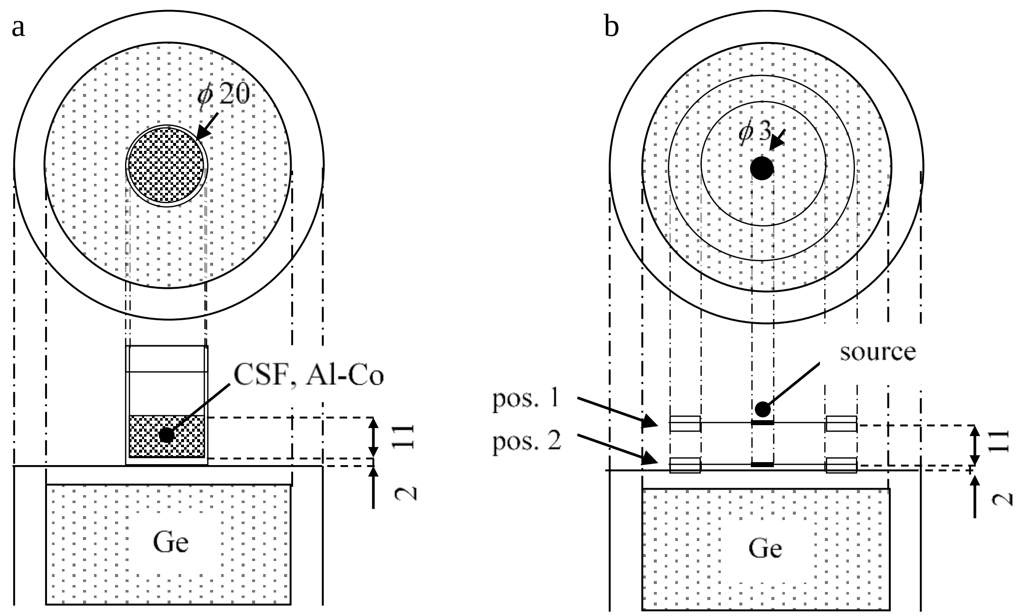

Fig 2 Position of the lyophilized CSF and dissolved Al-Co wire samples (a), and of the disk source (b) with respect to the detector end-cap. Dimensions in mm

The collection of the γ-spectrum emitted by the CSF sample started at $t_{\mathrm{d\,a}} = 667.890(10)\ \mathrm{h}$, lasted $t_{\mathrm{c\,a}} = 359.0633(1)\ \mathrm{h}$ and ended with a live time $t_{\mathrm{l\,a}} = 351.1856(1)\ \mathrm{h}$. The dissolved Al-Co monitor was successively measured. The collection of the γ-spectrum started at $t_{\mathrm{d\,m}} = 1034.10(1)$ h, lasted $t_{\mathrm{c\,m}} = 797.0(3)$ s and ended with a live time $t_{\mathrm{l\,m}} = 740.0(3)$ s. The quoted uncertainties correspond to uniform probability distributions assigned to the t_{d}, t_{c} and t_{l} values and having 60 s, 0.5 s and 0.5 s half-widths, respectively.

Detection system characterization

Full-energy γ-peak detection efficiency

The $\varepsilon_{\mathrm{p}}^{\mathrm{geo}}$ values in (5) depend on the actual position and geometry of the measured samples. The dependence is strengthened when extensive samples are measured close to the detector end-cap, as in this case.

In principle, the reconstruction of the $\varepsilon_{\mathrm{p}}^{\mathrm{geo}}$ versus the γ-energy, E_γ, might be performed by measuring the γ-emissions of an extensive standard source having the same shape as the analyte and monitor sample and located at the same position with respect to the detector end-cap. In addition, the material of the source should have the same major elemental composition as the monitor and analyte sample in order to mimic the γ self-absorption.

Actually, a more flexible procedure based on a computational technique coupled to a quasi-point standard source measured at large source-detector distance is commonly adopted [16]; geometries and major elemental composition of sample and layers between the Ge crystal and sample are required.

As an approximated alternative, we recorded two γ-spectra with a disk standard source positioned at the vertical ends of the measured extended samples, as shown in Figure 2b. The efficiency of the (virtual) extensive source, $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$, was estimated by the average of the disk efficiencies in positions 1 and 2, $\varepsilon_{\mathrm{p\,pos1}}^{\mathrm{disk}}$ and $\varepsilon_{\mathrm{p\,pos2}}^{\mathrm{disk}}$, respectively.

The coincidence free γ-emissions selected to reconstruct the efficiency curves were ^{241}Am 59.54 keV, ^{109}Cd 88.03 keV, ^{57}Co 122.06 keV, ^{139}Ce 165.86 keV, ^{113}Sn 391.70 keV, ^{137}Cs 661.66 keV, ^{54}Mn 834.85 keV and ^{65}Zn 1115.54 keV.

The $\varepsilon_{\mathrm{p\,pos1}}^{\mathrm{disk}}$, $\varepsilon_{\mathrm{p\,pos2}}^{\mathrm{disk}}$ and $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ versus E_γ data were fitted by the equation model

$$\ln \varepsilon_{\mathrm{p}} = a_1 E_\gamma + a_0 + a_{-1} E_\gamma^{-1} + a_{-2} E_\gamma^{-2} + a_{-3} E_\gamma^{-3}, \quad (6)$$

where a_1, a_0, a_{-1}, a_{-2} and a_{-3} are the fitting parameters. Best values, including uncertainties and correlation matrix, were calculated using the algorithm implemented in the OriginPro 2017.

The values obtained with the $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ data were $a_1 = -4.72(43) \times 10^{-1}$ MeV^{-1}, $a_0 = -3.229(57)$, $a_{-1} = 4.03(20) \times 10^{-1}$ MeV, $a_{-2} = -3.20(22) \times 10^{-2}$ MeV^2, $a_{-3} = -5.73(75) \times 10^{-4}$ MeV^3; the corresponding correlation matrix is shown in Table 1.

Table 1 Correlation matrix of the fitting parameters obtained with the $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ data

	a_1	a_0	a_{-1}	a_{-2}	a_{-3}
a_1	1.000	-0.973	0.884	-0.804	0.748
a_0	-0.973	1.000	-0.957	0.896	-0.848
a_{-1}	0.884	-0.957	1.000	-0.984	0.957
a_{-2}	-0.804	0.896	-0.984	1.000	-0.993
a_{-3}	0.748	-0.848	0.957	-0.993	1.000

The $\varepsilon_{\mathrm{p\,pos1}}^{\mathrm{disk}}$, $\varepsilon_{\mathrm{p\,pos2}}^{\mathrm{disk}}$ and $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ versus E_γ curves and the $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ residuals are plotted in Figure 3a and Figure 3b, respectively. The error bars indicate a 95% confidence interval due to fitting, taking into account the correlations.

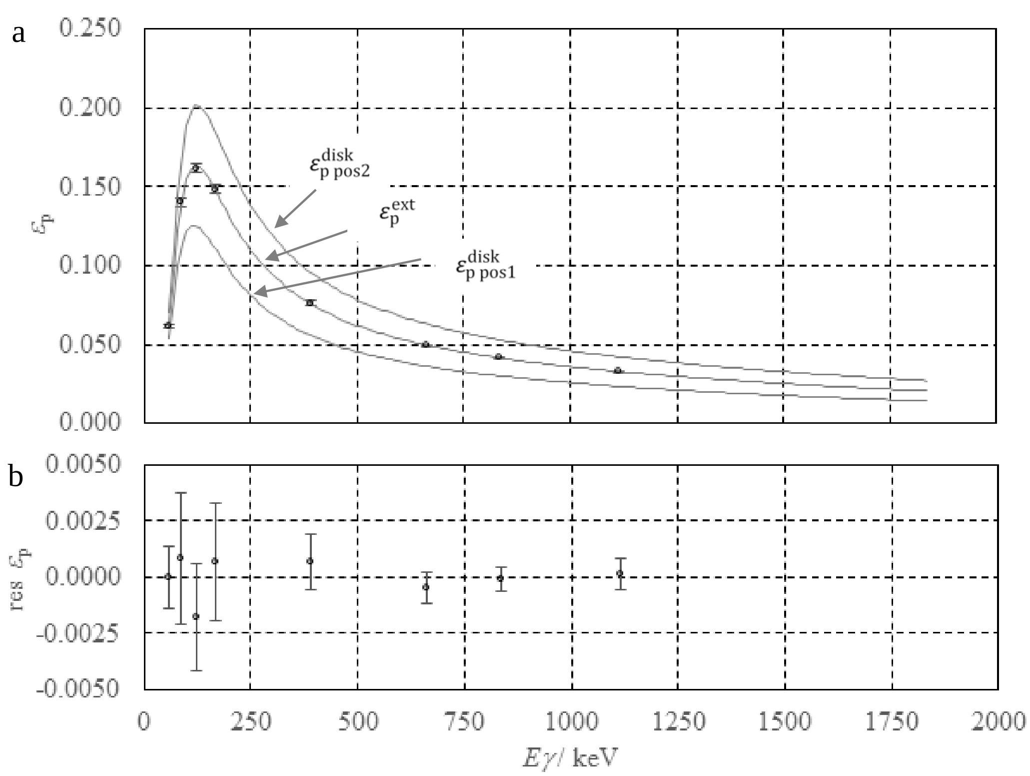

Fig 3 $\varepsilon_{\mathrm{p\,pos2}}^{\mathrm{disk}}$, $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ and $\varepsilon_{\mathrm{p\,pos2}}^{\mathrm{disk}}$ versus E_γ curves (a) and the residuals obtained with the $\varepsilon_{\mathrm{p}}^{\mathrm{ext}}$ data (b). The error bars indicate a 95% confidence interval due to fitting

Possible differences in counting positions of the measured samples with respect to the (virtual) extensive source were considered according to:

$$\frac{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}} = \frac{\varepsilon^{\mathrm{ext}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{ext}}_{\mathrm{p\,a}}} \frac{(1-\delta\varepsilon_{\mathrm{r\,m}}\,\Delta d_{\mathrm{m}})}{(1-\delta\varepsilon_{\mathrm{r\,a}}\,\Delta d_{\mathrm{a}})}, \quad (7)$$

where Δd_{m} and Δd_{a} are the vertical position differences between the dissolved Al-Co wire and the (virtual) extensive source and between the lyophilized CSF sample and the (virtual) extensive source, respectively, and $\delta\varepsilon_{\mathrm{r,m}}$ and $\delta\varepsilon_{\mathrm{r,a}}$ are the relative variations of the detection efficiency per unit of vertical position for the monitor and the analyte, respectively.

The $\delta\varepsilon_{\mathrm{r}}$ values were obtained from the ratio of $\left(\varepsilon^{\mathrm{disk}}_{\mathrm{p\,pos2}} - \varepsilon^{\mathrm{disk}}_{\mathrm{p\,pos1}}\right)/\varepsilon^{\mathrm{ext}}_{\mathrm{p}}$ to the difference between the vertical positions 1 and 2, i.e. 11 mm, and plotted versus E_γ in Figure 4.

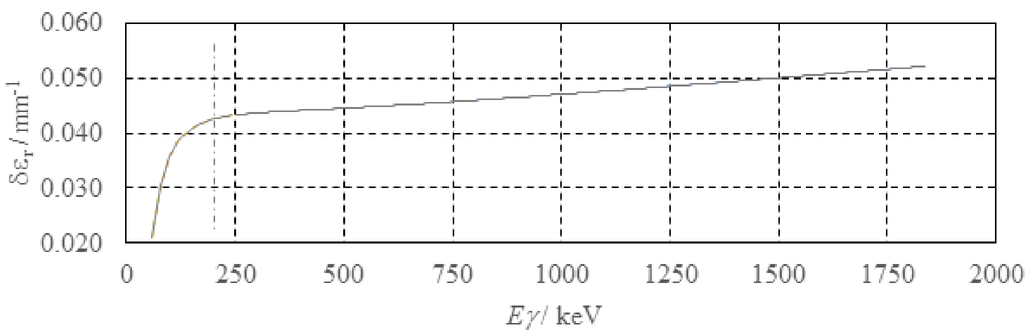

Fig 4 $\delta\varepsilon_{\mathrm{r}}$ versus E_γ curve. The vertical dashed line at about 240 keV splits the curve in two different regions

The data were fitted by $\delta\varepsilon_{\mathrm{r}} = d_0 + d_1 E_\gamma$ and $\delta\varepsilon_{\mathrm{r}} = e_0 + e_1 E_\gamma + e_2 E_\gamma^2 + e_3 E_\gamma^3 + e_4 E_\gamma^4$, for γ-energies above and below the 240 keV threshold, respectively. The resulting values were $e_4 = -7.10 \times 10^{-11}$ keV^{-4}, $e_3 = 5.19 \times 10^{-8}$ keV^{-3}, $e_2 = -1.43 \times 10^{-5}$ keV^{-2}, $e_1 = 1.78 \times 10^{-3}$ keV^{-1}, $e_0 = -4.46 \times 10^{-2}$ and $d_1 = 5.56 \times 10^{-6}$ keV^{-1}, $d_0 = 4.17 \times 10^{-2}$.

Peak-to-total ratio

True-coincidence occurs when two or more cascading γ-photons are emitted with negligible time delay by a radionuclide. The effect becomes significant when samples are measured close to the detector end-cap.

The number of counts collected in the full-energy γ-peak, n_{p}, is adjusted using the correction factor

$$\mathrm{COI} = \left(1 - L_{\gamma}\right)\left(1 + S_{\gamma}\right), \tag{8}$$

where L_{γ} and S_{γ} are the overall probabilities for coincidence loss and summing, respectively [4].

The formulae adopted to calculate L_{γ} and S_{γ} values depend on the cascade schemes and include several nuclear parameters, the most important ones being the absolute emission probability of the γ-photons, P_{γ}, the branching ratio, a_{γ}, and the total internal conversion coefficient, α_{t}. In addition, $\varepsilon_{\mathrm{p}}^{\mathrm{geo}}$ and the peak-to-total ratio, P/T, of the detection system are required.

E.g., the probability for coincidence loss of γ_{A} and γ_{B} in the case of $\gamma_{\mathrm{A}} \rightarrow \gamma_{\mathrm{B}}$ decay scheme is

$$L_{\gamma_{\mathrm{A}}} = a_{\gamma_{\mathrm{B}}} c_{\gamma_{\mathrm{B}}} \frac{\varepsilon_{\mathrm{p}\,\gamma_{\mathrm{B}}}^{\mathrm{geo}}}{(P/T)_{\gamma_{\mathrm{B}}}} \text{ and } L_{\gamma_{B}} = \frac{P_{\gamma_{\mathrm{A}}}}{P_{\gamma_{\mathrm{B}}}} a_{\gamma_{\mathrm{B}}} c_{\gamma_{\mathrm{B}}} \frac{\varepsilon_{\mathrm{p}\,\gamma_{\mathrm{A}}}^{\mathrm{geo}}}{(P/T)_{\gamma_{\mathrm{A}}}}, \tag{9}$$

respectively, where $c_{\gamma} = 1/(1 + \alpha_{\mathrm{t}\,\gamma})$, whereas the probability for coincidence summing of γ_{A} with the $\gamma_{\mathrm{B}} \rightarrow \gamma_{\mathrm{C}}$ decay scheme is

$$S_{\gamma_{\mathrm{A}}} = \frac{P_{\gamma_{\mathrm{B}}}}{P_{\gamma_{\mathrm{A}}}} a_{\gamma_{\mathrm{C}}} c_{\gamma_{\mathrm{C}}} \frac{\varepsilon_{\mathrm{p}\,\gamma_{\mathrm{B}}}^{\mathrm{geo}} \varepsilon_{\mathrm{p}\,\gamma_{\mathrm{C}}}^{\mathrm{geo}}}{\varepsilon_{\mathrm{p}\,\gamma_{\mathrm{A}}}^{\mathrm{geo}}}. \tag{10}$$

A compilation of the nuclear parameters values and the cascade schemes concerning the radionuclides generally used in NAA are reported in [4].

Similar to $\varepsilon_{\mathrm{p}}^{\mathrm{geo}}$, the P/T ratio versus E_{γ} data can be ideally obtained from γ-spectra of coincidence free radionuclides embedded in extensive sources having the same material and shape as the analyte and monitor sample and located at the same position with respect to the detector end-cap. In practice, since the P/T ratio is above all depending on the position and to a smaller extent on the composition and geometry of the samples, use of quasi-point γ-sources might be accepted.

In this study, we used five γ-emissions, i.e. ^{241}Am 59.54 keV, ^{170}Tm 84.25 keV, ^{203}Hg 279.19 keV, ^{137}Cs 661.66 keV and ^{65}Zn 1115.54 keV, to reconstruct the P/T ratio curve.

The data were fitted by $\log P/T = b_0 + b_1 \log E_\gamma$ and $\log P/T = c_0 + c_1 \log E_\gamma + c_2 (\log E_\gamma)^2$, for γ-energies above and below the 170 keV threshold, respectively. To avoid a discontinuity, the first derivative with respect to $\log E_\gamma$ of the latter equation model at 170 keV was imposed to be the b_1 value. The resulting values were $b_1 = -0.571$, $b_0 = 1.079$, $c_2 = -1.625$, $c_1 = 6.678$ and $c_0 = -7.006$.

The P/T ratio versus E_γ curve is plotted in Figure 5.

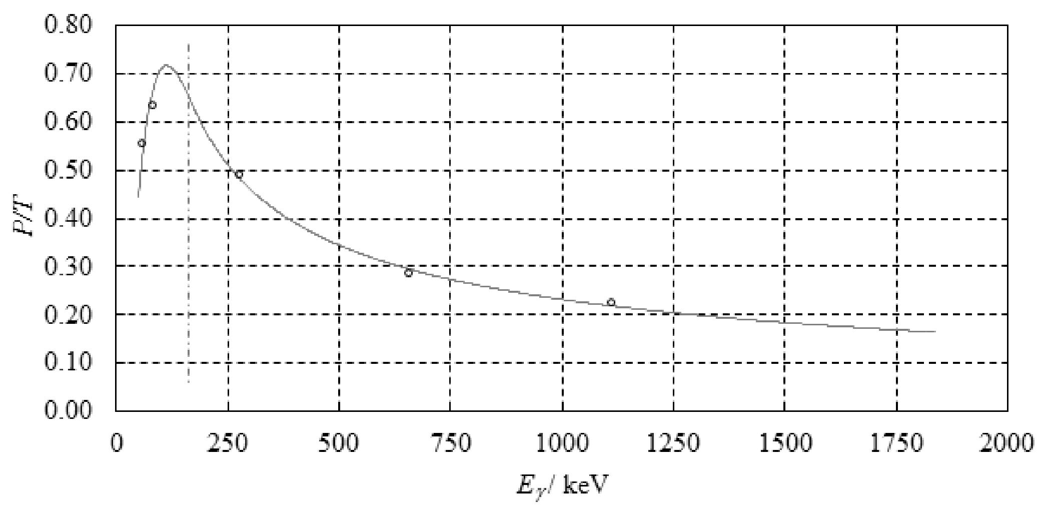

Fig 5 P/T ratio versus E_γ curve. The vertical dashed line at about 170 keV splits the curve in two different regions

Results and discussion

The analysis of the γ-spectrum of the lyophilized CSF sample pointed out ^{233}Pa, ^{51}Cr, ^{131}Ba, ^{124}Sb, ^{46}Sc, ^{86}Rb, ^{59}Fe, ^{65}Zn and ^{60}Co γ-emissions produced by neutron capture reactions from ^{232}Th, ^{50}Cr, ^{130}Ba, ^{123}Sb, ^{45}Sc, ^{85}Rb, ^{58}Fe, ^{64}Zn and ^{59}Co. The mass concentrations of the corresponding elements were quantified using the ^{60}Co γ-emission of the monitor.

The number of counts collected in the γ-peaks were evaluated with the algorithm implemented in the ROI32 analysis engine of the Gamma Vision software. The γ-peak energies and n_p values of the detected radionuclides in the CSF sample and monitor are reported in Table 2; the uncertainty (conservatively) assigned to E_γ corresponds to a uniform distribution with 0.2 keV half-width whereas the n_p uncertainty is due to counting statistics, including background.

Table 2 γ-peak energies and corresponding number of counts of the detected radionuclides

Radionuclide	E_γ / keV	n_p / 1
$^{233}Pa^{(CSF)}$	311.90(12)	$1.017(24) \times 10^5$
$^{51}Cr^{(CSF)}$	320.10(12)	$5.26(15) \times 10^4$
$^{131}Ba^{(CSF)}$	496.30(12)	$5.08(12) \times 10^4$
$^{124}Sb^{(CSF)}$	1691.00(12)	$2.47(21) \times 10^2$
$^{46}Sc^{(CSF)}$	889.30(12)	$1.3070(80) \times 10^5$
$^{86}Rb^{(CSF)}$	1077.00(12)	$4.56(44) \times 10^3$
$^{59}Fe^{(CSF)}$	1099.30(12)	$9.46(59) \times 10^3$
$^{65}Zn^{(CSF)}$	1115.50(12)	$1.2260(47) \times 10^5$
$^{60}Co^{(CSF)}$	1173.20(12)	$4.68(44) \times 10^3$
$^{60}Co^{(monitor)}$	1173.20(12)	$1.3749(44) \times 10^5$

The full-energy γ-peak detection efficiencies ratio, $\varepsilon_\mathrm{p\,m}^\mathrm{geo}/\varepsilon_\mathrm{p\,a}^\mathrm{geo}$, was computed according to (7) using a_1, a_0, a_{-1}, a_{-2}, a_{-3} and d_1, d_0, e_0, e_1, e_2, e_3, e_4 to obtain $\varepsilon_\mathrm{p\,m}^\mathrm{ext}/\varepsilon_\mathrm{p\,a}^\mathrm{ext}$ and $\delta\varepsilon_\mathrm{r}$, respectively, as a function of E_γ. The uncertainty of the $\varepsilon_\mathrm{p\,m}^\mathrm{ext}/\varepsilon_\mathrm{p\,a}^\mathrm{ext}$ was evaluated taking into account uncertainties and correlations of the fitting parameters whereas a uniform probability distribution with a (conservative) 20% relative half-width was directly assigned to the $\delta\varepsilon_\mathrm{r}$ value. In addition, it was assumed that the vertical position of the samples was within ±0.5 mm with respect to the (virtual) extensive γ-source; accordingly, $\Delta d_\mathrm{m} = \Delta d_\mathrm{a} = 0.00(29)$ mm, the quoted uncertainty corresponding to a uniform probability distribution having 0.5 mm half-width.

The true-coincidence correction factors ratio, $\mathrm{COI_m}/\mathrm{COI_a}$, was obtained via (8) using b_0, b_1, c_0, c_1 and c_2 to determine P/T as a function of E_γ. A uniform probability distribution with a (conservative) 20% relative half-width was directly assigned to the P/T value. The effect due to possible differences in counting positions was neglected; specifically, $\varepsilon_\mathrm{p}^\mathrm{geo}$ was used instead of $\varepsilon_\mathrm{p}^\mathrm{ext}$ in (9) and (10). Cascade schemes, notations and P_γ, a_γ, α_t values proposed in [4] were adopted with uncertainties corresponding to uniform probability distributions having 0.0002, 0.02 and 0.02 half-widths, respectively.

A list of neutron capture reactions and $t_{1/2}$, $k_{0\,\mathrm{Au}}$, Q_0, $\bar{E}_\mathrm{r}$ values recommended in the k_0 database [14] and used in this study are reported in Table 3 for reader's convenience.

Table 3 Neutron capture reactions and adopted $t_{1/2}$, $k_{0\,\mathrm{Au}}$, Q_0, $\bar{E}_\mathrm{r}$ values.

Reaction	$t_{1/2}$ / h	$k_{0\,\mathrm{Au}}$ / 1	Q_0 / 1	$\bar{E}_\mathrm{r}$ / eV
^{232}Th(n,γ)^{233}Pa	647.280(48)	2.520(13) × 10^{-2}	11.50(41)	54.40(49)
^{50}Cr(n,γ)^{51}Cr	664.800(58)	2.620(13) × 10^{-3}	0.53(11)	753(83) × 10^{1}
^{130}Ba(n,γ)^{131}Ba	276.0(14)	6.480(13) × 10^{-5}	24.8(50)	69.9(35)
^{123}Sb(n,γ)^{124}Sb	1444.80(72)	1.410(16) × 10^{-2}	28.8(11)	28.2(18)
^{45}Sc(n,γ)^{46}Sc	2011.92(48)	1.2200(49)	0.430(86)	513(87) × 10^{1}
^{85}Rb(n,γ)^{86}Rb	447.12(48)	7.650(77) × 10^{-4}	14.80(37)	839(50)
^{58}Fe(n,γ)^{59}Fe	1068.00(14)	7.770(39) × 10^{-5}	0.975(10)	64(15) × 10^{1}
^{64}Zn(n,γ)^{65}Zn	5863.2(24)	5.720(23) × 10^{-3}	1.91(10)	256(26) × 10^{1}
^{59}Co(n,γ)^{60}Co	46207.2(72)	1.3200(53)	1.993(60)	136.0(69)

Values and uncertainties assigned to t_i, $t_\mathrm{d\,a}$, $t_\mathrm{c\,a}$, $t_\mathrm{l\,a}$, $t_\mathrm{d\,m}$, $t_\mathrm{c\,m}$, $t_\mathrm{l\,m}$, μ, f, α, m_a, m_m, w_m and v are given in the section 3. The thermal and epithermal neutron self-shielding of the lyophilized CSF sample and of the dissolved (and diluted) Co monitor were considered insignificant. Accordingly, $G_\mathrm{th\,m} = G_\mathrm{th\,a} = G_\mathrm{e\,m} = G_\mathrm{e\,a} = 1.000$ with negligible uncertainty.

Uncertainty budget

The spreadsheet technique was applied to set up the uncertainty budget of the analyte mass concentration, ρ_a, via the measurement model (5).

The input quantities for ρ_{a} were t_{i}, μ, $t_{1/2\ \mathrm{a}}$, $t_{1/2\ \mathrm{m}}$, $t_{\mathrm{d\ a}}$, $t_{\mathrm{c\ a}}$, $t_{\mathrm{l\ a}}$, $t_{\mathrm{d\ m}}$, $t_{\mathrm{c\ m}}$, $t_{\mathrm{l\ m}}$, $n_{\mathrm{p\ a}}$, $n_{\mathrm{p\ m}}$, $k_{0\ \mathrm{Au}}(\mathrm{a})$, $k_{0\ \mathrm{Au}}(\mathrm{m})$, $G_{\mathrm{th\ a}}$, $G_{\mathrm{e\ a}}$, $G_{\mathrm{th\ m}}$, $G_{\mathrm{e\ m}}$, f, α, $Q_{0\ \mathrm{a}}$, $\bar{E}_{\mathrm{r\ a}}$, $Q_{0\ \mathrm{m}}$, $\bar{E}_{\mathrm{r\ m}}$, $\varepsilon_{\mathrm{p\ m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\ a}}^{\mathrm{geo}}$, $\mathrm{COI_m}/\mathrm{COI_a}$, m_{m}, m_{a}, w_{m} and v. The intermediate quantities λ_{a}, λ_{m}, δ_{a}, δ_{m}, ξ_{a}, ξ_{m}, $Q_{0\ \mathrm{a}}(\alpha)$ and $Q_{0\ \mathrm{m}}(\alpha)$ were calculated for information.

For simplicity, the $\varepsilon_{\mathrm{p\ m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\ a}}^{\mathrm{geo}}$ and $\mathrm{COI_m}/\mathrm{COI_a}$ values and uncertainties were computed separately via the measurement models (7) and (8), respectively. The input quantities for $\varepsilon_{\mathrm{p\ m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\ a}}^{\mathrm{geo}}$ were a_1, a_0, a_{-1}, a_{-2}, a_{-3}, $E_{\gamma\ \mathrm{m}}$, $E_{\gamma\ \mathrm{a}}$, Δd_{a}, Δd_{m}, $\delta\varepsilon_{\mathrm{r\ a}}$ and $\delta\varepsilon_{\mathrm{r\ m}}$ while the input quantities for $\mathrm{COI_m}/\mathrm{COI_a}$ were a_1, a_0, a_{-1}, a_{-2}, a_{-3} and additional parameters depending on the cascade scheme, e.g. E_γ, a_γ, c_γ, P/T and P_γ either for the monitor and for the analyte. The quantities e_4, e_3, e_2, e_1, e_0, d_1 and d_0 used to compute $\delta\varepsilon_{\mathrm{r}}$ and the quantities b_1, b_0, c_2, c_1 and c_0 used to compute P/T were given for information. The (small) correlation effect due to the shared parameters a_1, a_0, a_{-1}, a_{-2} and a_{-3} was neglected.

The formulae were implemented in a MS excel file [17] consisting of nine worksheets, one for each quantified analyte. A single worksheet included four sections. Irradiation time, day and time of the irradiation end, day and time of the γ-counting start, outputs of the Gamma Vision software, target nuclide and produced radionuclide were given in the first section, called "Irradiation and γ-spectrometry". Values, standard uncertainties and correlation coefficients of the input quantities were added in the main section, called "Uncertainty budget of ρ_{a}", with the exception of the $\varepsilon_{\mathrm{p\ m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\ a}}^{\mathrm{geo}}$ and $\mathrm{COI_m}/\mathrm{COI_a}$ ratios, whose data were added and calculated in two sub-sections, called "Uncertainty budget of $\varepsilon_{\mathrm{p\ m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\ a}}^{\mathrm{geo}}$" and "Uncertainty budget of $\mathrm{COI_m}/\mathrm{COI_a}$, respectively.

Values and combined uncertainties of ρ_{a}, $\varepsilon_{\mathrm{p\ m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\ a}}^{\mathrm{geo}}$ and $\mathrm{COI_m}/\mathrm{COI_a}$ were calculated together with sensitivity coefficients of the input quantities and their relative contribution; the matrix formalism was used to propagate the uncertainties via the correlation matrices $\boldsymbol{R}_{\rho_{\mathrm{a}}}$, $\boldsymbol{R}_{\varepsilon_{\mathrm{p\ m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\ a}}^{\mathrm{geo}}}$ and $\boldsymbol{R}_{\mathrm{COI_m}/\mathrm{COI_a}}$.

The analysis quantified 2.32(11) × 10^{-10} g $\mathrm{mL^{-1}}$ of Th, 2.096(99) × 10^{-9} g $\mathrm{mL^{-1}}$ of Cr, 6.89(96) × 10^{-8} g $\mathrm{mL^{-1}}$ of Ba, 4.01(39) × 10^{-11} g $\mathrm{mL^{-1}}$ of Sb, 5.06(15) × 10^{-11} g $\mathrm{mL^{-1}}$ of Sc, 8.00(85) × 10^{-10} g mL^{-1} of Rb, 3.87(27) × 10^{-8} g mL^{-1} of Fe, 2.220(77) × 10^{-8} g mL^{-1} of Zn and 3.24(31) × 10^{-11} g mL^{-1} of Co.

The uncertainty budgets are given in the developed MS excel file available in the Supplementary Information; cells dealing with informative or intermediate data were grayed. In $\boldsymbol{R}_{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}}$ and $\boldsymbol{R}_{\mathrm{COI_m/COI_a}}$, we set the correlation coefficients of a_1, a_0, a_{-1}, a_{-2} and a_{-3} according to the data shown in Table 1; in addition, as a first attempt, in $\boldsymbol{R}_{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}}$, we set to the unity value the correlation between $\delta\varepsilon_{\mathrm{r\,a}}$ and $\delta\varepsilon_{\mathrm{r\,m}}$, and in $\boldsymbol{R}_{\mathrm{COI_m/COI_a}}$, we set to the unity value the correlation between P/T_γ values, if existing.

A survey of the main contributors to the combined uncertainties is given in Table 4 while the (complete) Cr budget is shown in the Supplementary Information.

Table 4 Main contributors to the combined uncertainty of the quantified elements. Input quantities, X_i, are explained in the text. The index I is the relative contribution of X_i

Th		Cr		Ba		Sb		Sc		Rb		Fe		Zn		Co	
X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %	X_i	I / %
$\frac{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}}$	26.7	$n_{\mathrm{p\,a}}$	35.3	$Q_{0\,\mathrm{a}}$	89.3	$n_{\mathrm{p\,a}}$	77.6	$\frac{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}}$	49.3	$n_{\mathrm{p\,a}}$	83.4	$n_{\mathrm{p\,a}}$	78.0	$\frac{\mathrm{COI_m}}{\mathrm{COI_a}}$	33.1	$n_{\mathrm{p\,a}}$	92.8
$n_{\mathrm{p\,a}}$	25.1	$\frac{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}}$	27.4	$\frac{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}}$	3.2	$\frac{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}}$	8.0	v	16.0	$\frac{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}}$	3.5	$\frac{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}}$	7.9	$\frac{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}}$	32.6	$\frac{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}}{\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}}$	4.1
$\frac{\mathrm{COI_m}}{\mathrm{COI_a}}$	16.1	$\frac{\mathrm{COI_m}}{\mathrm{COI_a}}$	17.6	$n_{\mathrm{p\,a}}$	2.9	$Q_{0\,\mathrm{a}}$	6.6	w_m	10.9	$\frac{\mathrm{COI_m}}{\mathrm{COI_a}}$	3.5	$\frac{\mathrm{COI_m}}{\mathrm{COI_a}}$	6.9	v	12.3		
$Q_{0\,\mathrm{a}}$	12.0	v	6.5					$Q_{0\,\mathrm{a}}$	5.8					w_m	8.4		
v	6.4	w_m	4.5					$n_{\mathrm{p\,a}}$	4.1					$Q_{0\,\mathrm{a}}$	4.1		

In summary, the uncertainty of the results was largely due to $\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}$, $n_{\mathrm{p\,a}}$ and $\mathrm{COI_m/COI_a}$. In a few cases, v, w_m and m_m had an influence while the 20% uncertainty of the $Q_{0\,\mathrm{a}}$ recommended in the k_0 database [14] had the overriding effect for the determination of Ba.

It is worth to observe that the contribution to $\varepsilon^{\mathrm{geo}}_{\mathrm{p\,m}}/\varepsilon^{\mathrm{geo}}_{\mathrm{p\,a}}$ due to possible differences in counting positions of samples could be canceled if the monitor element was embedded in the analyte sample [18, 19]; this was confirmed by setting the correlation coefficient between Δd_{a} and Δd_{m} in $\boldsymbol{R}_{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$ to the unity value.

Besides, the result of Co deserves attention. In this case, i.e. when the analyte corresponds to the monitor element and the same γ-emission is used, the k_0-NAA turns into the relative-NAA. Accordingly, we set to the unity value the correlation coefficients between $t_{1/2}$, $t_{1/2}$, $k_{0\,\mathrm{Au}}$, Q_0 and $\bar{E}_{\mathrm{r}}$ in $\boldsymbol{R}_{\rho_{\mathrm{a}}}$ and between E_γ, a_γ, c_γ, P/T_γ in $\boldsymbol{R}_{\mathrm{COI_m/COI_a}}$. As a result, the contributions due to the "intrinsic" uncertainty characteristic of the k_0-NAA method [8] and due to the $\mathrm{COI_m/COI_a}$ were reset; moreover, the correlation coefficients of a_1, a_0, a_{-1}, a_{-2} and a_{-3} in $\boldsymbol{R}_{\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}}$ made their contribution to $\varepsilon_{\mathrm{p\,m}}^{\mathrm{ext}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{ext}}$ zero as well.

Conclusions

The spreadsheet approach proved to be suitable to set up the uncertainty budget for the k_0-standardisation method in NAA when the majority of the recognized sources of error are considered and the measurement model is written to limit the correlations between input quantities. The use of the matrix formalism was straightforward to propagate the uncertainties by taking into account the covariances.

A MS excel file was developed and tested for the determination of Th, Cr, Ba, Sb, Sc, Rb, Fe, Zn and Co in a lyophilized CSF sample. The uncertainty budget of each element was compiled once the estimates, the uncertainties and the correlation coefficients associated with the input quantities were specified. The value and combined uncertainty of the result were calculated and the most overriding contributors were pointed out.

It was shown that when the monitor element corresponded to the analyte element and the same γ-emission was used, the worksheet set up the uncertainty budget for the relative-NAA method; this makes the proposed approach applicable either in the relative- and k_0-NAA.

The MS excel file is open and free available to users. The implemented measurement model allows a broad application, e.g. in case of different sample material, monitor element, neutron irradiation and γ-spectrometry conditions. The extension to other elements is possible by a simple duplication of the existing worksheets; only the modification of the formulae adopted to compute the $\mathrm{COI_m/COI_a}$ ratio might be required for other decay schemes.

References

1. EURACHEM/CITAC Guide 3rd Ed. (2012) Quantifying Uncertainty in Analytical Measurement

2. Guide to the Expression of Uncertainty in Measurement (1993), International Organization for Standardisation (ISO), Geneva

3. Quantifying Uncertainty in Nuclear Analytical Measurements (2004), International Atomic Energy Agency

4. de Corte F (1987) The k_0-standardisation, a move to the optimization of neutron activation analysis. Habilitation Thesis, University of Gent, Belgium

5. Robouch P, Arana G, Eguskiza M, Pommé S, Etxebarria N (2000) Uncertainty budget for k_0-NAA. J Radioanal Nucl Chem. 245:195-197

6. Kragten J (1994) Calculating standard deviations and confidence intervals with a universally applicable spreadsheet technique. Analyst. 119:2161-2165

7. Younes N, Robouch P (2003) A web tool for calculating k_0-NAA uncertainties. J Radioanal Nucl Chem. 257:665-667

8. Bucar T, Smodis B (2006) Assessment of the intrinsic uncertainty of the k_0-based NAA. Nucl Instr Meth Phys Res A. 564:683-687

9. Smodis B, Bucar T (2006) Overall measurement uncertainty of k_0-based neutron activation analysis. J Radioanal Nucl Chem. 269:311-316

10. Simonits A, de Corte F, Hoste J (1975) Single-comparator methods in reactor neutron activation analysis. J Radioanal Chem. 24:31-46

11. Girardi F, Guzzi G, Pauly J (1965) Reactor neutron activation analysis by the single comparator method. Anal Chem. 37:1085-1092

12. Høgdahl OT (1965) In: Proc. Symp. Radiochemical Methods of Analysis, Salzburg, 19-23 October, 1964, IAEA, Vienna, p. 23

13. D'Agostino G, Di Luzio M, Mana G, Oddone M (2017) A new low-uncertainty measurement of the ^{31}Si half-life. Metrologia. 54:410-416

14. k_0-International Scientific Committee, Database of Recommended k_0-Data, released January 11, 2016 http://www.kayzero.com/k0naa/k0naaorg/Nuclear_Data_SC/Entries/2016/1/11_New_k0-data_Library_2015.html

15. Di Luzio M, Oddone M, Prata M, Alloni D, D'Agostino G (2017) Measurement of the neutron flux parameters f and α at the Pavia TRIGA Mark II reactor. J Radioanal Nucl Chem. 312:75-80

16. Moens L, De Donder J, Xilei L, de Corte F, De Wispelaere A, Simonits A, Hoste J (1981) Calculation of the absolute peak efficiency of gamma-ray detectors for different counting geometries. Nucl Instr Methods Phys Res. 187:451-471

17. Microsoft Excel 2013, Microsoft Corporation, Redmond, Washington, US

18. Acharya R, Nair AGC, Sudarshan K, Reddy AVR, Goswami A (2007) Development and applications of the k_0-based internal mono standard INAA method. Appl Rad and Isot. 65:164-169

19. D'Agostino G, Di Luzio M, Mana G, Martino L, Oddone M, Sasso C (2016) Quantification of the void volume in single-crystal silicon. Anal Chem. 88:11678-11683

Supplementary information

Developed worksheet file

See the MS excel file "uncertainty_k0_spreadsheet.xlsx"

Uncertainty budget of Cr

The (complete) uncertainty budget of the Cr determination is here reported. According to Table 1, the most overriding contributors to the combined uncertainty were $n_{\mathrm{p\,a}}$ (35.3%), $\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}$ (27.4%) and $\mathrm{COI_m}/\mathrm{COI_a}$ (17.6%). The remaining 19.7% was due to v, w_{m}, $Q_{0\,\mathrm{a}}$,m_{m}, $k_{0\,\mathrm{Au}}(\mathrm{a})$, $k_{0\,\mathrm{Au}}(\mathrm{m})$, $Q_{0\,\mathrm{m}}$, $n_{\mathrm{p\,m}}$, α and *f*, in decreasing order of importance. As regards to $\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}$ (see Table 2), the main contributors were a_1, a_{-1}, a_{-2} (44.0%), Δd_{a} (25.6%) and Δd_{m} (31.5%), while the uncertainty of $\mathrm{COI_m}/\mathrm{COI_a}$ (see Table 3) was due to $P/T_{\gamma 2\,\mathrm{m}}$ (96.1%).

The a_0 value is not affecting $\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}$. In fact, a_0 in equation (6) models a constant multiplying factor that is deleted from the detection efficiency ratio. In addition, since we considered $\Delta d_{\mathrm{a}} = \Delta d_{\mathrm{m}} = 0$ mm, the contribution of $\delta\varepsilon_{\mathrm{r\,a}}$ and $\delta\varepsilon_{\mathrm{r\,m}}$ was reset.

Table 1 Uncertainty budget of the mass concentration of Cr in the lyophilized CSF sample. Quantities are explained in the text. The column Index gives the relative contribution of the input quantity, X_{i}, to the output quantity, Y. Values of the sensitivity coefficient, c_{i}, and Index are omitted for those quantities that are not actual inputs of the measurement model.

Quantity X_{i}	Unit $[X_{\mathrm{i}}]$	Value x_{i}	Std. Uncertainty $u(x_{\mathrm{i}})$	Sens. Coeff. c_{i}	Index I / %
t_{i}	s	2.1600×10^{4}	1.7×10^{1}	3.0×10^{-16}	0.0
μ	1	4.45×10^{-2}	5×10^{-4}	-1.0×10^{-10}	0.0
$t_{1/2\,\mathrm{a}}$	s	2.39328×10^{6}	2.1×10^{2}	1.1×10^{-16}	0.0
λ_{a}	s^{-1}	2.89622×10^{-7}	2.5×10^{-11}		
$t_{1/2\,\mathrm{m}}$	s	1.66346×10^{8}	2.6×10^{4}	-1.2×10^{-17}	0.0
λ_{m}	s^{-1}	4.16690×10^{-9}	6.5×10^{-13}		
$t_{\mathrm{d\,a}}$	s	2.404405×10^{6}	3.5×10^{1}	6.1×10^{-16}	0.0

$t_{\mathrm{c\,a}}$	s	1.29262800 × 10^6	2.9 × 10^-1	3.6 × 10^-16	0.0
$t_{\mathrm{l\,a}}$	s	1.26426800 × 10^6	2.9 × 10^-1	-1.7 × 10^-15	0.0
$t_{\mathrm{d\,m}}$	s	3.722775 × 10^6	3.5 × 10^1	-8.7 × 10^-18	0.0
$t_{\mathrm{c\,m}}$	s	7.9700 × 10^2	2.9 × 10^-1	-1.1 × 10^-13	0.0
$t_{\mathrm{l\,m}}$	s	7.400 × 10^2	2.9 × 10^-1	2.9 × 10^-12	0.0
δ_{a}	1	1.022	0.000		
δ_{m}	1	1.077	0.001		
ξ_{a}	1	1.00098	1 × 10^-5		
ξ_{m}	1	1.00319	4 × 10^-5		
$n_{\mathrm{p\,a}}$	1	5.26 × 10^4	1.5 × 10^3	4.0 × 10^-14	35.3
$n_{\mathrm{p\,m}}$	1	1.3749 × 10^5	4.4 × 10^2	-1.5 × 10^-14	0.5
$k_{0\,\mathrm{Au}}(\mathrm{a})$	1	2.620 × 10^-3	1.3 × 10^-5	-8.0 × 10^-7	1.1
$k_{0\,\mathrm{Au}}(\mathrm{m})$	1	1.3200	5.3 × 10^-3	1.6 × 10^-9	0.7
$G_{\mathrm{th\,a}}$	1	1.000	0.000	-2.0 × 10^-9	0.0
$G_{\mathrm{e\,a}}$	1	1.000	0.000	-7.7 × 10^-11	0.0
$G_{\mathrm{th\,m}}$	1	1.000	0.000	1.8 × 10^-9	0.0
$G_{\mathrm{e\,m}}$	1	1.000	0.000	2.7 × 10^-10	0.0
f	1	1.560 × 10^1	3.3 × 10^-1	-1.2 × 10^-11	0.2
α	1	-3.60 × 10^-2	6.4 × 10^-3	-9.0 × 10^-10	0.3
$Q_{0\,\mathrm{a}}$	1	5.3 × 10^-1	1.1 × 10^-1	-1.8 × 10^-10	3.6
$\bar{E}_{\mathrm{r\,a}}$	eV	7.53 × 10^3	8.3 × 10^2	-8.7 × 10^-17	0.0
$Q_{0\,\mathrm{a}}(\alpha)$	1	5.9 × 10^-1	1.5 × 10^-1		
$Q_{0\,\mathrm{m}}$	1	1.993	6.0 × 10^-2	1.4 × 10^-10	0.7
$\bar{E}_{\mathrm{r\,m}}$	eV	1.360 × 10^2	6.9	5.8 × 10^-14	0.0
$Q_{0\,\mathrm{m}}(\alpha)$	1	2.319	9.5 × 10^-2		
$\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}$	1	3.507 × 10^-1	8.7 × 10^-3	6.0 × 10^-9	27.4
$\mathrm{COI_m}/\mathrm{COI_a}$	1	8.57 × 10^-1	1.7 × 10^-2	2.4 × 10^-9	17.6
m_{m}	g	8.47 × 10^-3	5 × 10^-5	2.5 × 10^-7	1.6
m_{a}	g	2.4000 × 10^-1	5 × 10^-5	-8.7 × 10^-9	0.0
w_{m}	g g^-1	4.597 × 10^-3	4.6 × 10^-5	4.6 × 10^-7	4.5
v	mg L^-1	99.2	1.2	-2.1 × 10^-11	6.6
Y	$[Y]$	y	$u_{\mathrm{c}}(y)$		
ρ_{a}	g mL^-1	2.096 × 10^-9	9.9 × 10^-11		

Table 2. Uncertainty budget of the $\varepsilon_{\mathrm{p\,m}}^{\mathrm{geo}}/\varepsilon_{\mathrm{p\,a}}^{\mathrm{geo}}$ ratio given in Table 1.

Quantity X_{i}	Unit $[X_{\mathrm{i}}]$	Value x_{i}	Std. Uncertainty $u(x_{\mathrm{i}})$	Sens. Coeff. c_{i}	Index I / %
a_1	MeV^-1	-4.72 × 10^-1	4.3 × 10^-2	3.0 × 10^-1	74.1

a_0	1	-3.229	5.7 × 10^{-2}	0.0	0.0
a_{-1}	MeV	4.03 × 10^{-1}	2.0 × 10^{-2}	-8.0 × 10^{-1}	-43.1
a_{-2}	MeV^2	3.20 × 10^{-2}	2.2 × 10^{-3}	-3.2	13.0
a_{-3}	MeV^3	5.73 × 10^{-4}	7.5 × 10^{-5}	-1.0 × 10^{1}	-1.1
$E_{\gamma\ m}$	MeV	1.17320	1.2 × 10^{-4}	-2.5 × 10^{-1}	0.0
$E_{\gamma\ a}$	MeV	3.2010 × 10^{-1}	1.2 × 10^{-4}	9.2 × 10^{-1}	0.0
Δd_a	mm	0.00	0.29	1.5 × 10^{-2}	25.6
Δd_m	mm	0.00	0.29	-1.7 × 10^{-2}	31.5
e_4	keV^{-4}	-7.10 × 10^{-11}	0.00 × 10^{-11}		
e_3	keV^{-3}	5.19 × 10^{-8}	0.00 × 10^{-8}		
e_2	keV^{-2}	-1.43 × 10^{-5}	0.00 × 10^{-5}		
e_1	keV^{-1}	1.78 × 10^{-3}	0.00 × 10^{-3}		
e_0	1	-4.46 × 10^{-2}	0.00 × 10^{-2}		
d_1	keV^{-1}	5.56 × 10^{-6}	0.00 × 10^{-6}		
d_0	1	4.17 × 10^{-2}	0.00 × 10^{-2}		
$\delta\varepsilon_{r\ a}$	mm^{-1}	4.3 × 10^{-2}	5 × 10^{-3}	0.0	0.0
$\delta\varepsilon_{r\ m}$	mm^{-1}	4.8 × 10^{-2}	6 × 10^{-3}	0.0	0.0
Y	$[Y]$	y	$u_c(y)$		
$\varepsilon^{geo}_{p\ m}/\varepsilon^{geo}_{p\ a}$	1	3.507 × 10^{-1}	8.7 × 10^{-3}		

Table 3 Uncertainty budget of the COI_m/COI_a ratio given in Table 1. (*) Notation reported in [4] and adopted for the cascade scheme.

Quantity X_i	Unit $[X_i]$	Value x_i	Std. Uncertainty $u(x_i)$	Sens. Coeff. c_i	Index I / %
a_1	MeV^{-1}	-4.72 × 10^{-1}	4.3 × 10^{-2}	-1.9 × 10^{-1}	5.9
a_0	1	-3.229	5.7 × 10^{-2}	-1.4 × 10^{-1}	-4.9
a_{-1}	MeV	4.03 × 10^{-1}	2.0 × 10^{-2}	-1.1 × 10^{-1}	1.0
a_{-2}	MeV^2	3.20 × 10^{-2}	2.2 × 10^{-3}	-8.0 × 10^{-2}	-0.1
a_{-3}	MeV^3	5.73 × 10^{-4}	7.5 × 10^{-5}	-6.0 × 10^{-2}	0.0
b_1	1	-0.571	0.000		
b_0	1	1.079	0.000		
c_2	1	-1.625	0.000		
c_1	1	6.678	0.000		
c_0	1	-7.006	0.000		
$E_{\gamma 2\ m}$	keV	1.3325 × 10^{3}	1.2 × 10^{-1}	9.6 × 10^{-5}	0.0
$a_{\gamma 2\ m}$	1	1.000	0.012	-1.4 × 10^{-1}	0.9
$c_{\gamma 2\ m}$	1	1.000	0.012	-1.4 × 10^{-1}	0.9
$P/T_{\gamma 2\ m}$	1	0.197	0.023	7.3 × 10^{-1}	96.1

Y	$[Y]$	y	$u_c(y)$		
COI_m/COI_a	1	8.57×10^{-1}	1.7×10^{-2}		

This section will not appear in the printed version of your paper but it will contain a link; the webpage containing the electronic supplementary information will appear when one clicks on the hyperlink. Here you can list the details of your research which would be too long for the main text, *e.g.* a larger number of spectra *etc*. Start with 1 for Figure and Table numbers in this section.